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A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

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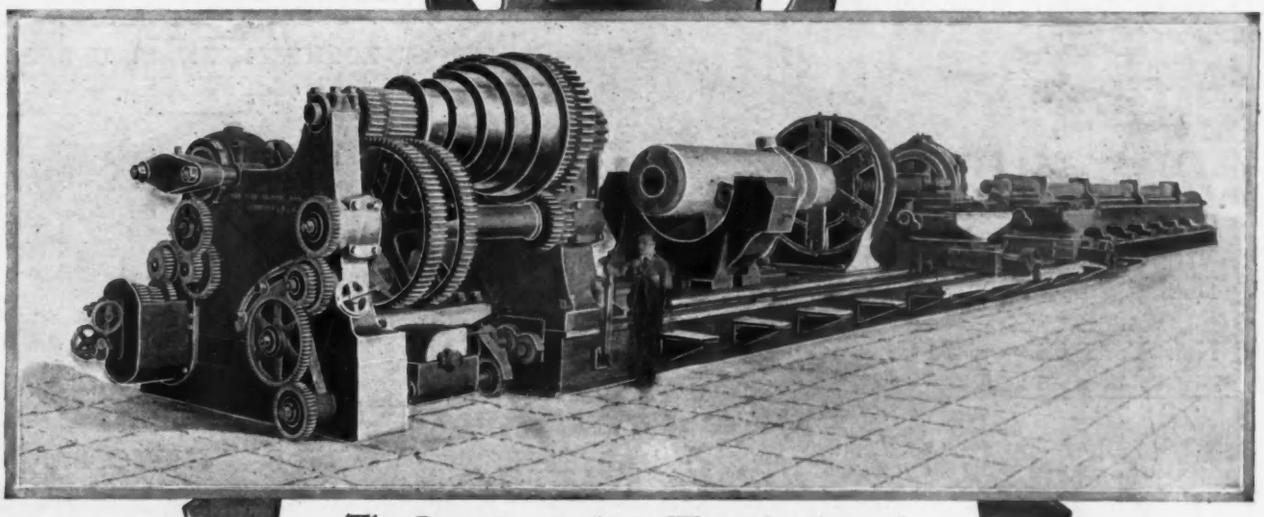

The Great Gun Lathe at Watervliet Arsenal.
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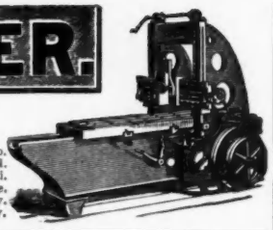
Length, 138 Feet.

No. 15.
April 9,
1896.

THE GRAY PLANER.



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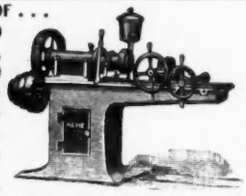

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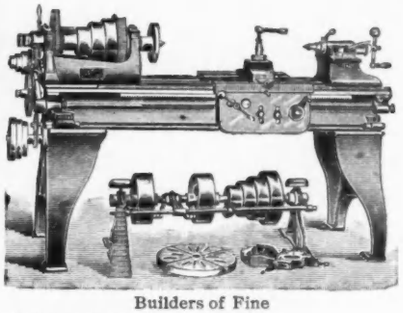

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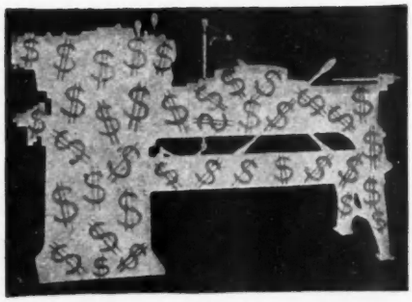

AN X RAY PHOTOGRAPH.

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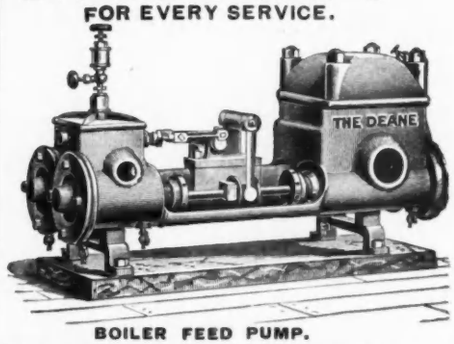

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NEW YORK, THURSDAY, APRIL 9, 1896.

VOLUME 19. ▲ ▲ ▲ NUMBER 15.

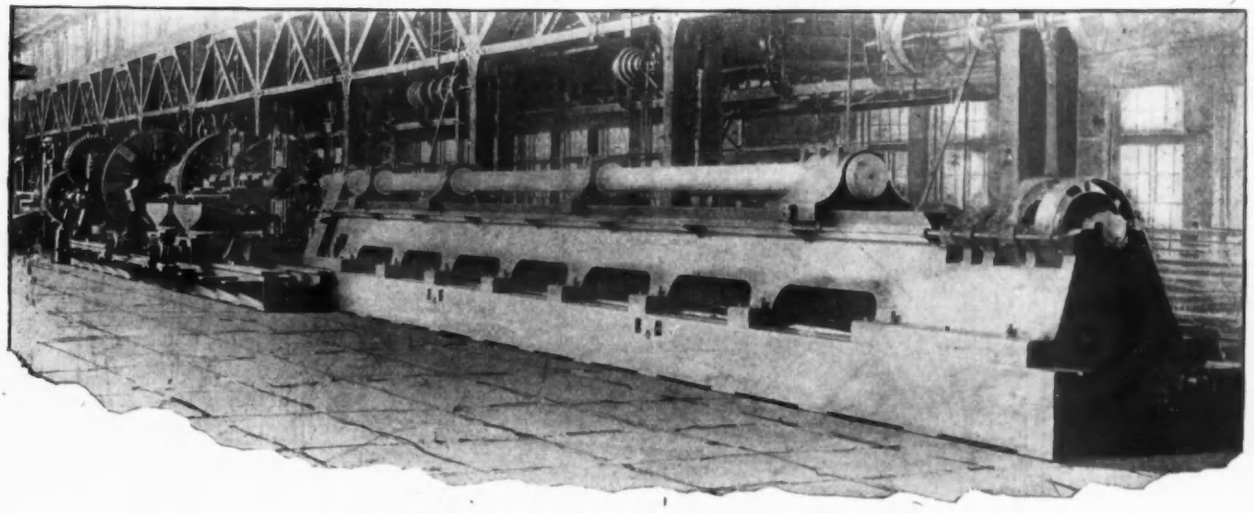
Lathe for Boring and Turning Sixteen-Inch Guns at Watervliet Arsenal.

As our readers know, the machinist and his allies of the drawing room, pattern shop, forge shop and foundry have been called upon to do a very large share of the work of building the "New Navy" and of preparing for coast defense. In addition to the work done upon the actual implements of war, very much has been done by them in the way of preparation and equipment called for by the character of the work to be done—work which, up to a few years ago, was unknown in this country. The industrial importance of this work is very great and its influence has been decidedly beneficial in many ways.

On account of the very great interest which every one engaged in any branch of machine construction must feel in this work, which has exerted such an important influence upon our craft, we feel certain we need make no apology for devoting a large share of this issue of the "American Machinist" to an illustrated description of one of the most notable tools that have been built in the prosecution of the work referred to; so far as we know, no such full and complete illustrations of such a machine tool have ever before been published. During the meeting of the American Society of Mechanical Engineers last fall, an excursion was organized to go to Plainfield to see this lathe. Those who saw it at that time will find our engravings and description interesting, and to those who did not enjoy that privilege it is safe to say that we are able to give a much more complete idea of the lathe and its construction than can be gained by simply looking at it as it stands complete.

An excellent idea of the general appearance of the lathe, as it stood upon the erecting floor in the machine shop of its builders, the Pond Machine Tool Company, of Plainfield, N. J., may be derived from an inspection of the engraving on this page and the large general engraving (an accurate reproduction of a photograph) which we give elsewhere in this issue. The lathe is one of a series of similar tools built for Watervliet Arsenal, West Troy, N. Y., from the designs of the Ordnance Department, United States Army. Following this description is an article written by Mr. Anthony Victorin, the engineer in charge of mechanical matters at Watervliet. Mr. Victorin is mainly to be credited with the design, though naturally the Pond shops experts had also something to do with it, and his article gives an excellent idea of how work is handled in such a lathe.

Before proceeding to a detailed description of the lathe, it may be well for the reader to have in mind the fact that we are dealing with a tool which weighs, finished, about 280 tons, or about four times the weight of a modern passenger locomotive, and which is 138 feet long; that the complete head stock alone weighs 52 tons, and each carriage 18 tons. The lathe is shown with a 10-inch gun in it, which gun, though it weighs 34 tons and is 31 feet long, is small for the lathe, which is designed for 16-inch guns which will weigh 142.5 tons and will be about 50 feet long. The bed of the lathe is in six sections, each of which weighs about 20 tons; that portion of the bed next the head stock, to which the rests and carriages are attached, being considerably wider than that portion which supports only the boring-bar carriage.



A VIEW OF THE LATHE IN THE SHOPS OF ITS BUILDERS.

THE HEAD STOCK.

Figs. 1 and 2, pages 2 and 3, show the construction of the head stock. The main spindle is of cast iron, 24 inches diameter at the main journal, and with a bearing, in a cast-iron shell, 2 ft. 7¾ in. long. This shell is tapered outside, as shown, 2 inches in 3 feet, and is split so that it can be adjusted to the spindle by means of a threaded collar at each end. The rear bearing is similar in construction, and is 16 inches

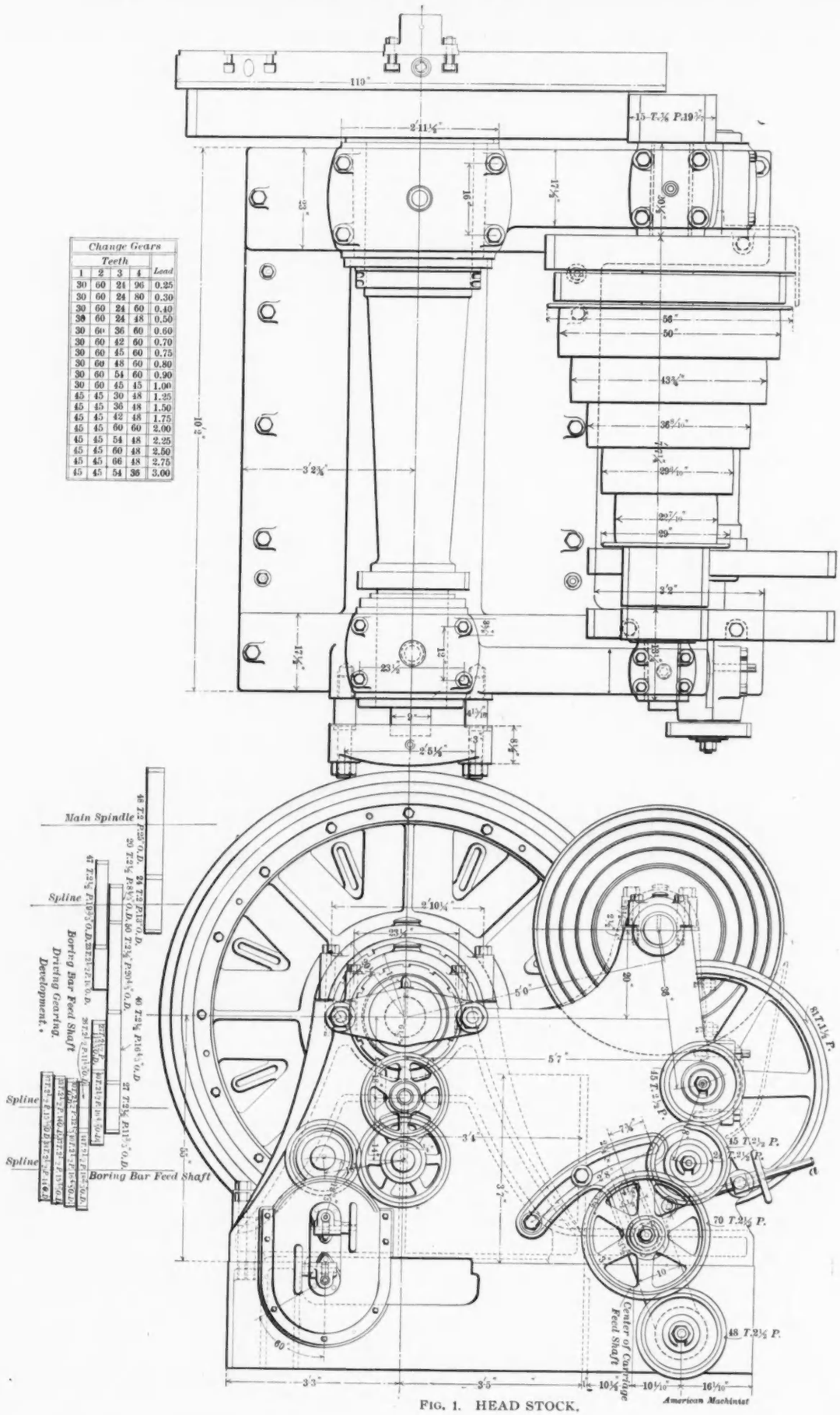


FIG. 1. HEAD STOCK.

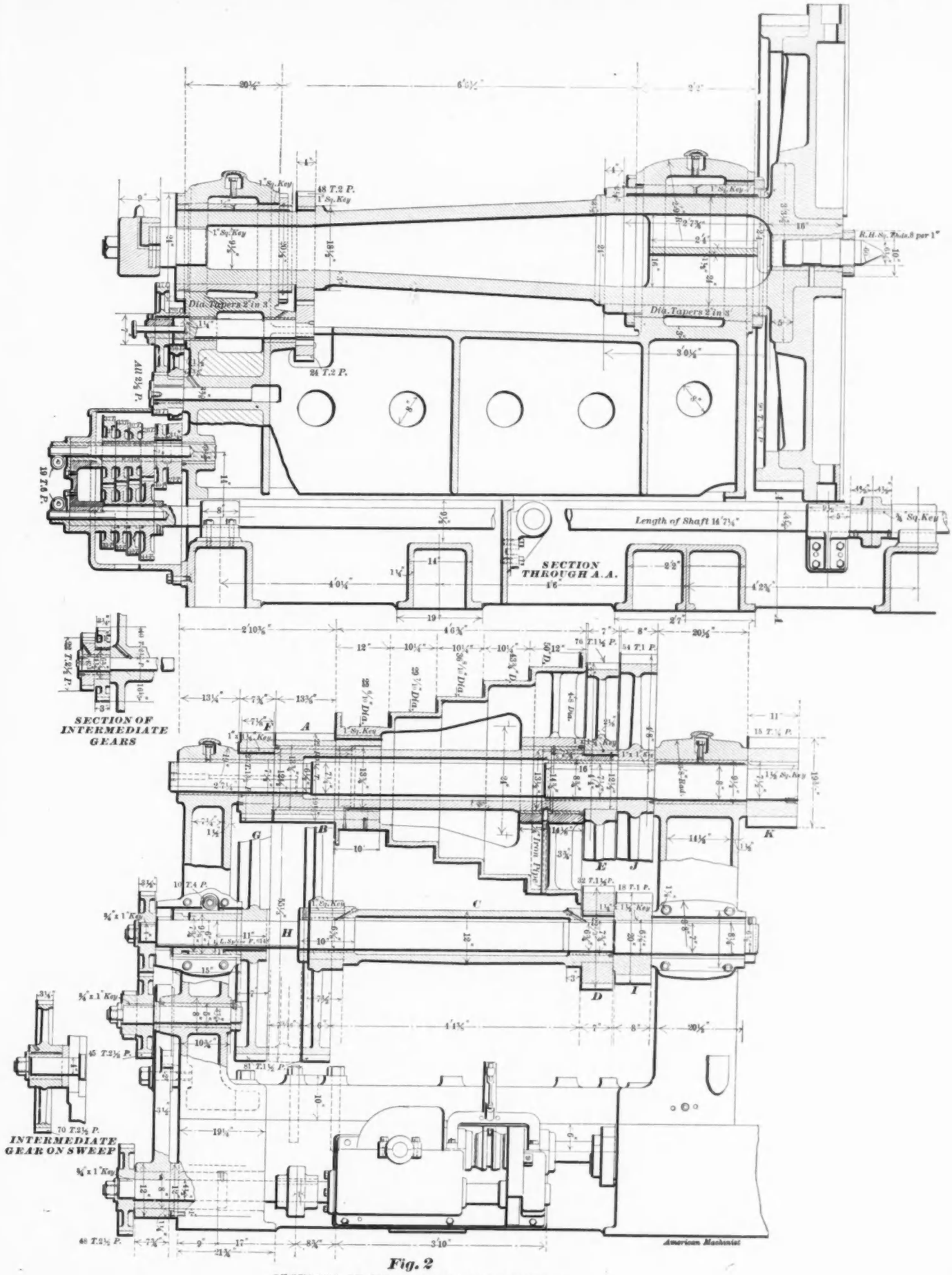


Fig. 2

SECTIONS OF HEAD-STOCK AND SPINDLE.

diameter, 25½ inches long. End thrust is taken by a yoke at the back, as shown, steel and bronze washers, ¾-inch thick, 6 inches diameter, being used.

Bolted solidly to the spindle is the cast-iron face plate, which alone weighs 13 tons and is shown separately in Fig. 3. To this face plate is bolted the steel (casting) ring gear, 10½ inches face, 8 feet 9¼ inches outside diameter and ⅞ diametral (3.59 inches circular) pitch, by which the plate is driven. This gear, like all the others about the lathe, is machine cut.

The cone pulley has five steps for a 10-inch belt, and drives the plate through two different arrangements of gearing, which, with the two different speeds of the countershaft, give twenty different speeds for the spindle, ranging from .22 to 9 revolutions per minute, and the change from one train of driving gears to the other is made by shifting one gear only.

Referring to Fig. 2, it will be seen that there is a wide-faced pinion *A* keyed to the cone pulley. This pinion is always in engagement with the gear wheel *B*, the upper part of which is shown broken away for the sake of clearness. Gear *B* is keyed to the sleeve or quill *C*, to which the pinion *D* is also keyed. This pinion engages with gear *E*, which is keyed to a quill that passes through the cone pulley and has keyed to its other extremity the pinion *F*, which drives gear *G*, which is splined to the shaft *H*. To this shaft is keyed the pinion *I*, which drives gear *J* and its shaft, to the right-hand extremity of which shaft is keyed the pinion *K*, which engages with the face-plate gear. Arranged in this way, the ratio between cone pulley and the face plate is 384¼ to 1.

Gear *G* can be shifted to the right to engage with pinion *A*, and when this is done the effect of *B*, *D* and *E* is eliminated. They remain in engagement and are in motion, but do not affect the driving. The ratio of cone pulley to face plate is then 54 to 1.

The face plate has eight jaws, arranged as shown in Fig. 3 (p. 5), four of the slots coming close to the center to enable the smaller work to be gripped by them, while all the jaws can be brought to bear upon the larger work. The jaws are moved upon the plate by square-threaded screws 2⅛ inches diameter, and when set can be clamped in place by the binding bolts shown. The jaws are steel castings, and to the face of each is attached a tempered steel gripping piece, which is seated in a curved seat, as shown in the cross-section, Fig. 3, the object of this arrangement being to allow the jaws to grip the work fairly and without cramping.

THE HEAD-STOCK FEED MECHANISM.

The feed motion for the boring bar is derived from the main spindle by means of the train of gearing shown at the left in Fig. 1, that for the tool carriages being taken from the back-gear shaft by the train of gearing shown at the right in the same figure, and in the sectional view, Fig. 2, both trains are shown. Taking, first, the carriage motion, it will be seen to be much the same in arrangement as is usually found on lathes, but there is a compounding stud independent of the intermediate stud which is on the swing-plate; and as this swing plate is 4½ inches thick and over 4 feet long, it cannot well be handled and set by hand, and is therefore provided with the screw *a*, Fig. 1, which is attached by a pin to the plate and passes through a swiveling stud fixed in the head-stock, at which point is a hand wheel 12 inches diameter, which is threaded to the screw and gives control of the plate when the binding bolts are loosened. The wheels in this train are 3¼ inches face and 2½ diametral pitch.

The short shaft which this train of gears gives motion to, drives both the splined rod from which the various carriage feeds are obtained and the lead-screw, these two lying parallel with each other within the bed. They are not driven by this shaft directly, however, but by a double-clutch mechanism, which is best shown in Fig. 4 (p. 5), where gear a^1, which constitutes one side of the double clutch, gets its motion from gear *b*, which is keyed to the short shaft referred to. The other side of the clutch turns in the same direction, but at slower speed, the ratio between the motions being 1 to 12½, owing to the fact that the left side of the clutch is driven by means of the double-threaded worm on the short shaft *s*, which drives the worm wheel shown, having 25 teeth. The two miter gears *c* and *d* complete the motion, and thus, when the clutch lever is thrown to the right or left, it changes all carriage feed motions, including those for screw-cutting, in the ratio of 12½ to 1, or, when placed in the intermediate position, stops all feeds, except for the boring-bar.

The lead screw, which is driven by this mechanism, is 5¾ inches diameter, 63 feet long, cut left-hand, 4 threads in 5 inches; and the splined shaft referred to is 4½ inches diameter, 67 feet long. Both are carried on drop bearings which support them at frequent intervals.

The feed train from the boring bar will be understood from an inspection of Fig. 1, where it is shown on the end view of the head stock, with a development at the left; and from Fig. 2, where a sectional view is given. The first gear of this train is at the right of the rear spindle bearing, and a stud arranged in the usual manner carries the motion through the head stock. In the end of the stud is a pull-pin and sliding key, by which either of the two gears upon the outer end of the stud is made to do the driving. Below is an arrangement of cone gears with sliding keys by which any desired rate of feed is obtained, the keys being set by means of hand wheels, best shown in the photograph. The upper sliding key controls only the two gears seen at the right of the upper cone gears in Fig. 2, and thus introduces another means of changing the speed ratio; while the lower hand wheel controls the cone gears, as shown. The pins which carry the keys turn with the studs, and their outer ends are therefore cut with annular rack teeth, with which the pinions engage. The numbers of teeth, and the pitch of the gears of this train, are all shown in the development at the left of Fig. 1.

LEAD-SCREW MECHANISM.

Having previously described the mechanism which is common to the splined feed shaft and to the lead-screw, we now take up the mechanism which is devoted solely to the lead-screw motion. The motion of the lead-screw is reversed, or stopped independently of all other motions by the vertical lever, near the head stock, which is grasped by the man in the photograph and is shown in Fig. 6 (p. 6). This lever works a double-ended clutch, shown in Figs. 6 and 7. This clutch is splined to shaft *a*, which is the shaft driven by the double-ended clutch shown in Fig 4. Being splined to shaft *a*, the clutch shown in Fig. 7 can drive either of the bevel gears at the right or left of it, and this motion is then taken through the vertical stud shown, to the train of spur gears above (shown in Figs. 5, 6 and 7), which further reduce the motion, and the final drive is by means of the bevel gears, one of which is shown on the end of the lead screw *c*, Fig. 7. The upper end of the stud *b* is squared so that, when the clutch is thrown out, the screw can be turned by means of a ratchet applied to this square. Screws can be cut up to 3-inch pitch, varying by tenths of an inch.

THE CARRIAGES.

Since the two carriages are in all respects precisely alike, the description of one of them will apply to both. It is shown in Figs. 8 to 18 (pp. 6, 7). Referring to Fig. 8, the lever at the lower right-hand corner of the carriage is the one by which the head-screw nut is opened and closed, the arrangement of the nut being clearly shown in the corresponding position in Fig. 9. It is 24 inches long and is in two parts, which completely encircle the screw when closed, and they are inclosed, as shown, so that they have a solid abutment against the carriage on all sides.

The movement of the two parts of the nut is effected by means of four short racks, two of which are on each part of the nut; and these racks are placed on opposite sides of a pinion which is on the same shaft with the lever, so that when the lever is moved the two parts of the nut move in opposite directions. The arrangement is shown in the lower right-hand portion of Fig. 9, where the position of the parts when the nut is closed is shown. Fig. 11 gives an end view of the nut and its mechanism, and it also shows, more plainly than any other view perhaps, how the nut is arranged to lock the carriage when opened to its fullest extent.

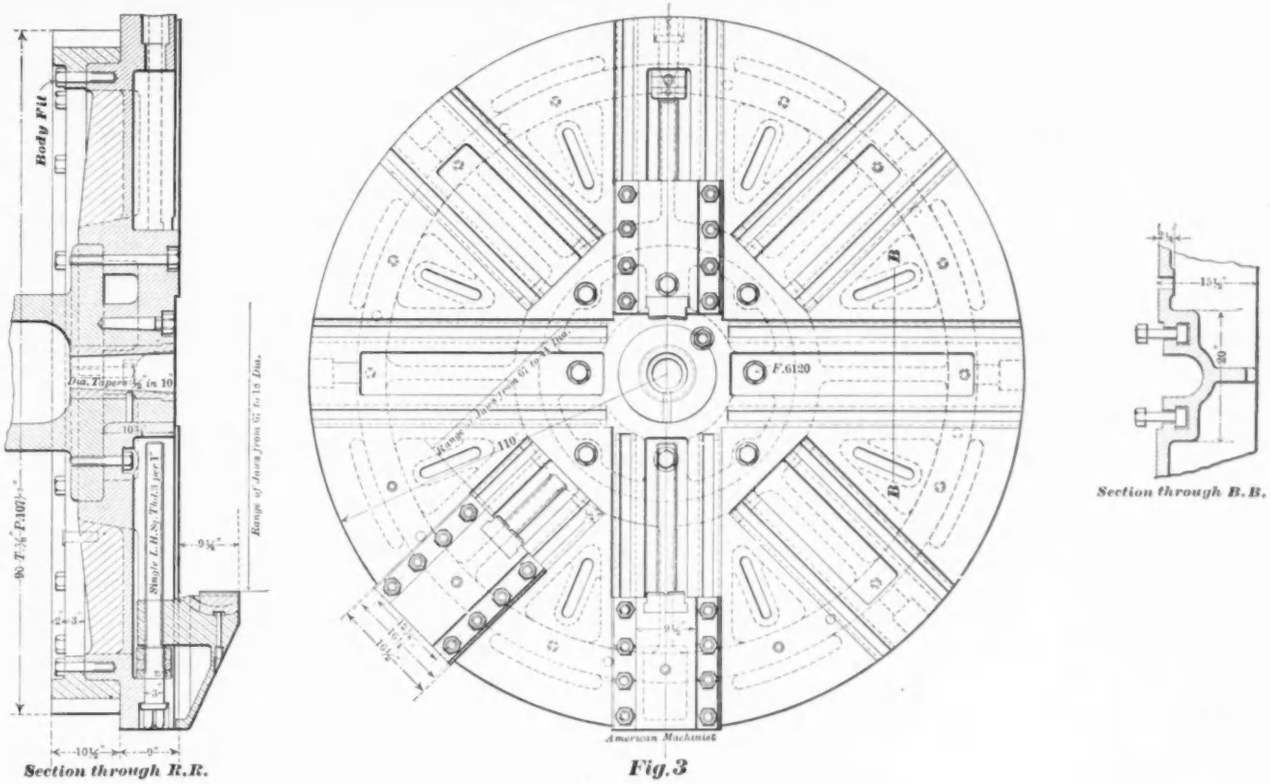


Fig. 3

THE FACE-PLATE.

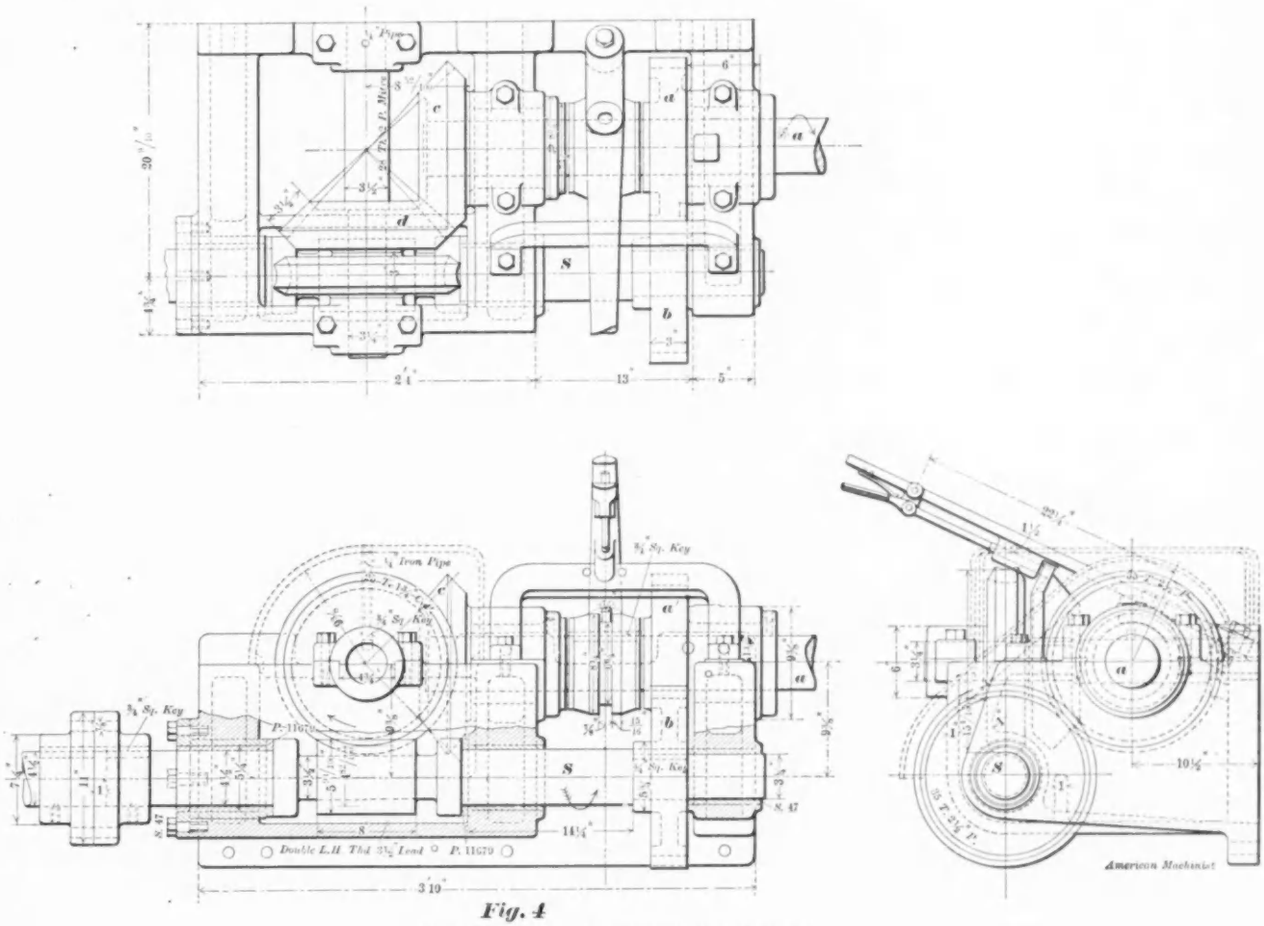
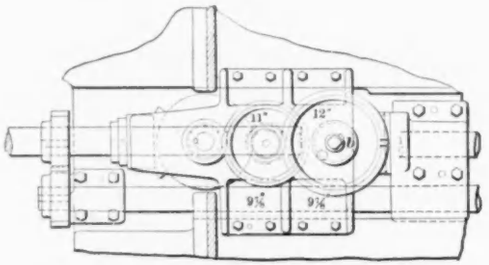


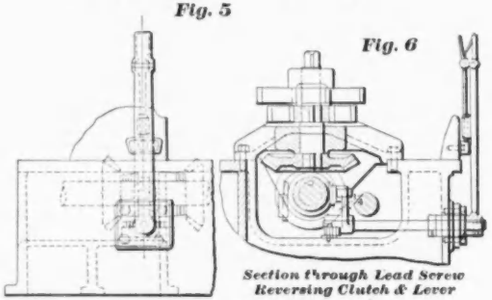
Fig. 4

CARRIAGE FEED DRIVING MECHANISM.



Plan of Lead Screw Feed Gearing

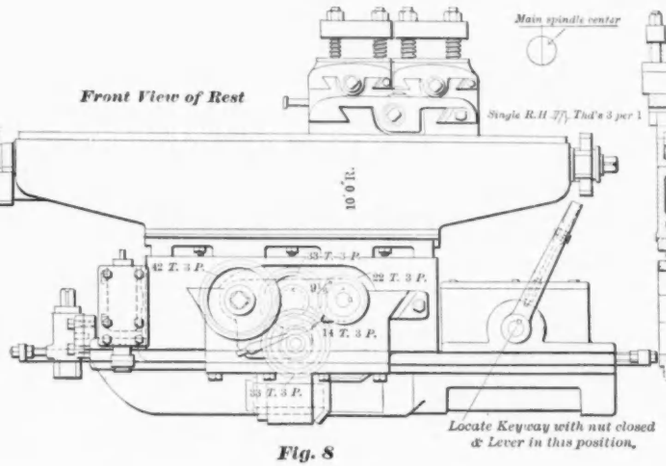
Fig. 5



Front Elevation of Clutch Reversing Lever

Section through Lead Screw Reversing Clutch & Lever

Fig. 6



Front View of Rest

Main spindle center

Single R.H. 7/8 Thd's 3 per 1

10' 0" R.

42 T. 3 P.

33 T. 3 P.

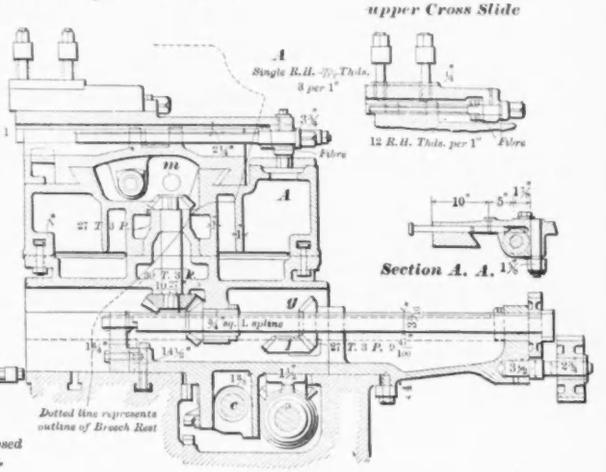
22 T. 3 P.

14 T. 3 P.

35 T. 3 P.

Locate Keyway with nut closed & Lever in this position.

Fig. 8



Cross Section through Swivel Center

Section through upper Cross Slide

A

Single R.H. 7/8 Thds. 3 per 1"

12 R.H. Thds. per 1" Fibre

Fibre

m

A

22 T. 3 P.

g

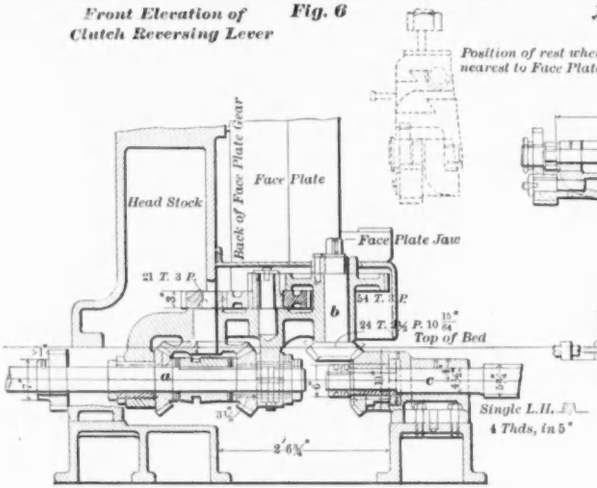
¾ sq. L. spline

27 T. 3 P.

Dotted line represents outline of Breech Rest

Section A. A.

Fig. 10



Position of rest when nearest to Face Plate

Head Stock

Back of Face Plate Gear

Face Plate

Face Plate Jaw

21 T. 3 P.

54 T. 3 P.

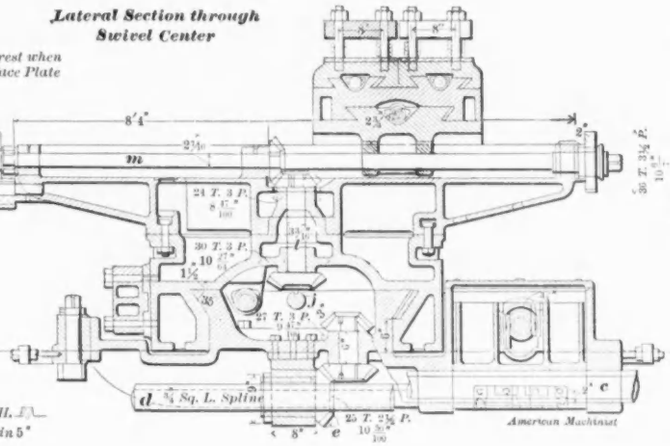
24 T. 3 P.

Top of Bed

Single L.H. 4 Thds. in 5"

Section through Lead Screw Gearing

Fig. 7



Lateral Section through Swivel Center

m

24 T. 3 P.

30 T. 3 P.

27 T. 3 P.

d ¾ Sq. L. Spline

25 T. 2½ P.

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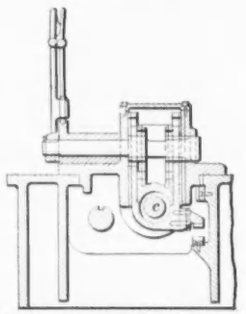
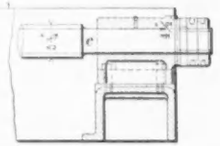
Fig. 9

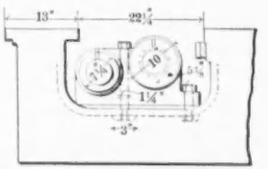


Section through Lead Screw Nut

Fig. 11



Section through Tail End Lead Screw Box



End View of Tail End Lead Screw Box

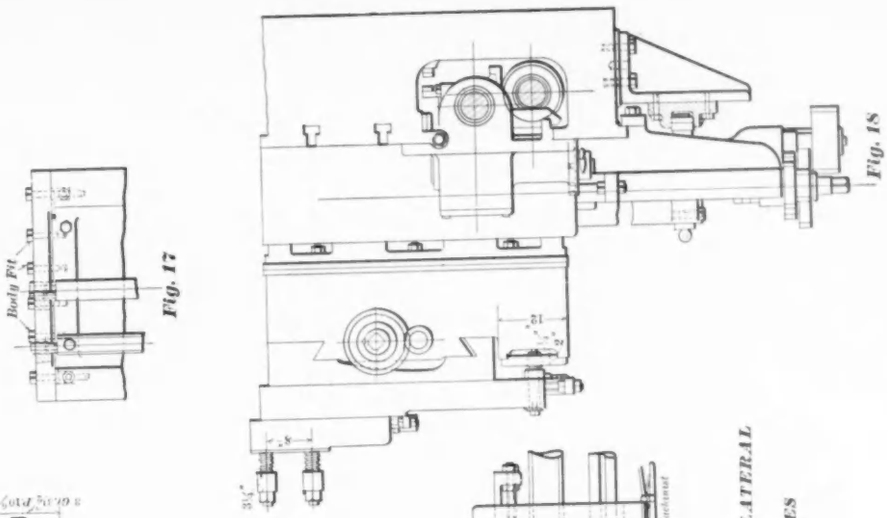
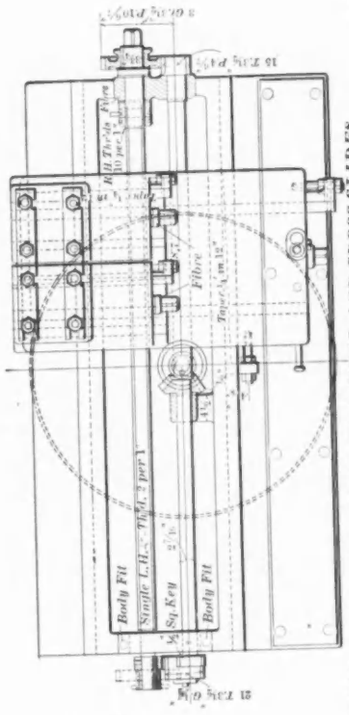
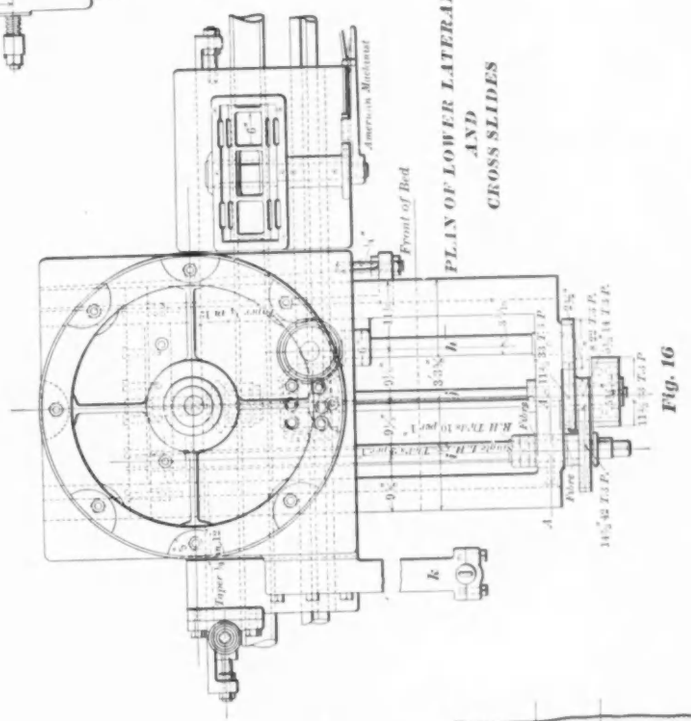


Fig. 18

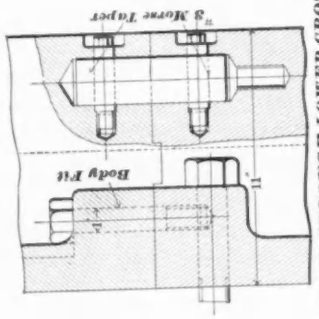
Fig. 17



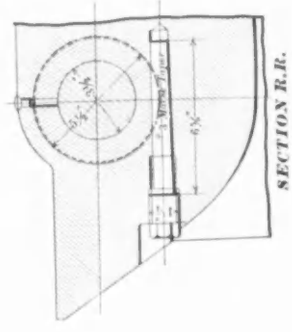
PLAN OF UPPER LATERAL AND CROSS SLIDES
Fig. 15



PLAN OF LOWER LATERAL AND CROSS SLIDES
Fig. 16



SECTION THROUGH LOWER CROSS SLIDE EXTENSION JOINT.
Fig. 13



SECTION R.R.
Fig. 14

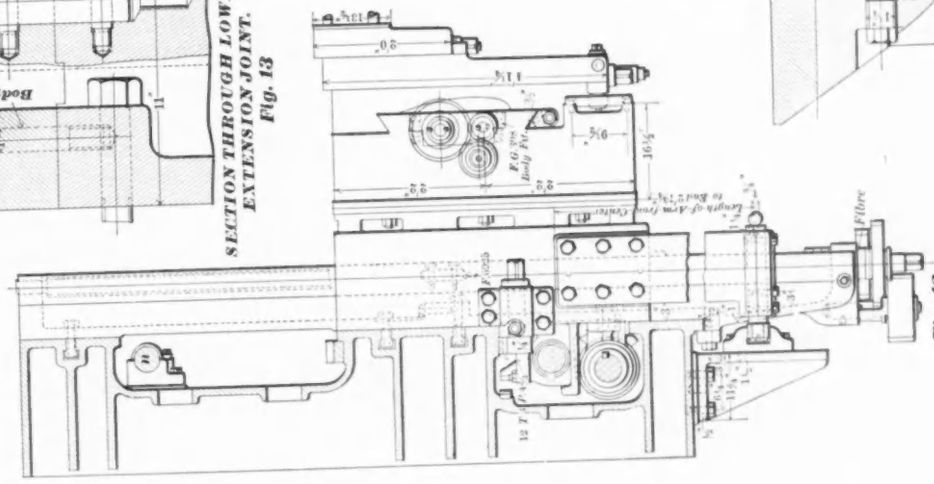


Fig. 12

This is accomplished by simply forming on the outside of the lower half of the nut a short section of a rack which, when the nut is opened as wide as possible, engages with a rack placed inside the bed under and to the right of the screw, as shown in Fig. 11. The movement of the carriage upon the bed, by hand, is by means of the pinion-and-rack movement shown at the left of Figs. 8 and 9.

The cross-feed motion, and the feed motion for the compound rest, are derived from the large splined feed shaft previously referred to; and, referring to Fig. 9, *d* is this shaft, to which is splined the miter gear *e*, from which motion is taken to miter gear *f*, which is shown also in Fig. 10. This drives miter gear *g*, Fig. 10, which gear is splined to a shaft which is best seen in Fig. 16, where it is marked *h*. This shaft extends out to the front of the carriage, where, by suitably arranged gearing, as shown, it drives both the cross-feed screw *i* and the splined shaft *j*, the latter carrying the motion to the center of the compound rest for the feed motion of the upper slide.

It will be noticed that there is a taper attachment applied to this cross-slide. The bar for this, which may be either straight or curved, as required, is placed on the brackets shown in front of the bed in the photograph, and a roller which is carried at the end of the arm *k*, Fig. 16, engages the bar and moves the cross-slide in or out as the carriage moves along the bed. When this attachment is being used, the cross-feed screw is allowed to slide endwise by means of the arrangement shown in Fig. 14, which is on an enlarged scale and shows the sliding bush which constitutes the outer bearing of the cross-feed screw, and is ordinarily held from endwise motion by the taper pin shown, but when this pin is removed is free to slide endwise with the screw and cross-slide.

Returning now to Fig. 9, a cross-section of the splined shaft *j* is seen; and this, by means of the miter gears and the vertical shaft *l*, drives the splined shaft *m*, which lies parallel to, and drives by spur gears, the traversing screw for the upper slide. An end view of the shaft *m* and the screw at the left of it, is shown in the cross-section, Fig. 10.

The cross-feed screw *i* and the traversing screw in the compound rest are squared for the reception of ratchet wrenches, by which they may be turned by hand; and, above the compound rest, is still another and shorter rest, in which there is no automatic feed, but to which a taper attachment is applied, arranged as shown in Figs. 10 and 12. This is designed to be used for turning curved shapes or short tapers. Finally, each tool is held upon its own independent rest, as shown in Fig. 8.

Ordinarily, either of the carriages will pass the rests in which the gun is supported; but it is sometimes desirable to get boring or facing tools nearer the center than is consistent with this requirement; and for that purpose, provision is made for extending the cross-slide of either carriage entirely across the bed. This is done by making each cross-slide an exact duplicate of the other, and providing a piece which is exactly like them in cross-section and can be joined to either carriage. The method of making the joint is shown at Fig. 13, and the splined shaft *j* and the cross-feed screw *i* are both spliced out in a similar manner, the requirement being that the joint shall be in all respects perfect with either carriage, there being but one piece to be used with either of them, as occasion may require. The rear end of this extension piece can be bolted to the bed by means of T-slots.

The circular base of the compound rest, which is graduated outside in degrees, is 4 feet 4 inches diameter. The compound-rest slide is 8 feet long, and the carriages have a bearing upon the bed of about the same length. The feeds range from .02 inch to .3 inch per revolution. As previously noted, each carriage weighs 18 tons.

THE BORING BAR AND ITS CARRIAGE.

We have previously described and shown (in Figs. 1 and 2) how the feed motion for the boring bar is derived from the main spindle of the lathe. It is transmitted from the head of the lathe to the foot by means of a steel shaft 4½ inches diameter, 137 feet long. This shaft is made in two sections for convenience in transportation, and is carried on drop bearings within the bed. It is splined for a portion of its length to provide for movement of the boring-bar carriage upon the bed, and its location within the bed is shown at *n*, Fig. 12.

Fig. 19 (p. 9) gives a side view of the boring bar and its carriage, and Figs. 20 and 21 give enlarged views of the mechanism for giving the bar its feed motion. The bar does not rotate, but bores by the rotation of the gun. By reference to Fig. 21 it will be seen that the shaft *n* drives a worm at *o*, which engages with a worm wheel above it, as most clearly shown in the cross-sectional view at the right. From thence the motion is taken, by the bevel gears shown, to the double-ended clutch above, which is on the boring-bar feed screw *q*, which is 4½ inches diameter, is cut double, left-hand, one thread per inch, and engages with a solid nut which is attached to the boring-bar bearing *r*. This bearing slides upon the boring-bar carriage and carries the bar with it by means of the collars shown, and as it comes to the other boring-bar supports, one of which is shown at the left of *r* in Fig. 21, it pushes them along with it, and when the reverse motion takes place these supports are drawn back by means of the latches *s*, which are disengaged and held at the proper places upon the carriage by the pins, one of which is shown holding the latch *s*, Fig. 21.

The boring bar in this lathe is of forged gun steel, 11 inches diameter, 61 feet 3½ inches long, and has a 4-inch hole through it. Its weight is 6 tons.

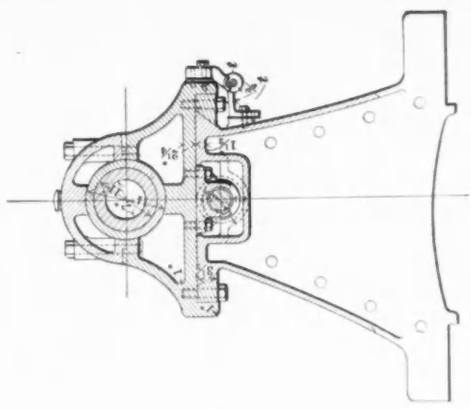
At the right of the double feed-clutch already mentioned are two clutch-pulleys (Fig. 21), which are driven by independent, open and crossed belts, and serve to give rapid traversing motion to the bar in either direction when desired. The feeds for the boring bar range from .008 inch to .17 inch per revolution of the gun, while the clutch pulleys mentioned give it a motion of 28 feet per minute independent of the motion of the gun.

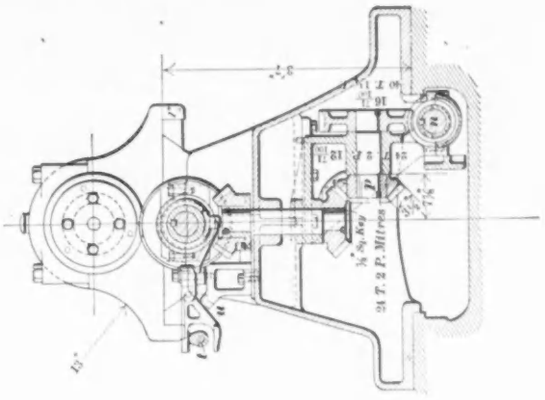
The feed screw extends entirely through the boring-bar carriage, and is squared at its left-hand end to receive a ratchet wrench, by which it can be turned by hand.

The motion of the bar is controlled by means of the shaft *t*, shown in Figs. 19, 20 and 22 (pp. 9, 10). This shaft is $1\frac{7}{8}$ inches diameter and extends the entire length of the boring-bar carriage. At its left-hand extremity it carries the hand wheel shown, by which it may be turned; and below and to the right of this hand wheel is the horizontal arm of a bell-crank lever, by which the shaft may be moved endwise (Fig. 19). At the other end of the shaft are two cams of peculiar form, which engage the clutch levers; and the arrangement is such that when the shaft *t* is turned to a certain position one of the clutch levers can be moved by it, while the other one is locked in its disengaged position and cannot be moved until the other clutch is disengaged and the shaft rotated half a revolution. By referring to Fig. 20 and the cross-sectional view at the right of Fig. 21, the arrangement will be readily understood. The levers are forked at their outer ends and inclose the cams, as shown. The upper arm of the fork is narrow enough to drop between the lugs on the cam in the position shown in Fig. 21, but the lower arm is too wide to go between these lugs; therefore, when they are turned downwards by the revolution of the shaft, they force the lever downwards into engagement with a slot at *u*, Fig. 21, which holds the lever in its disengaged position so that it cannot be moved; while at the same time the shaft *t* cannot be turned upon its axis, so as to unlock the other lever and throw it into engagement, until this one has been brought opposite the slot at *u* and locked. The photograph of the lathe, taken from the rear end and shown on page 1, will help the reader to understand the arrangement, and it is worth studying as a very ingenious and simple arrangement for accomplishing the purpose.

A tappet is fixed on the main boring-bar support *r*, which strikes collars fixed to the shaft *t*, and thus automatically disengages whichever clutch may be in engagement.

Figs. 22 and 23 (p. 10) show, on an enlarged scale, the mechanism at the other





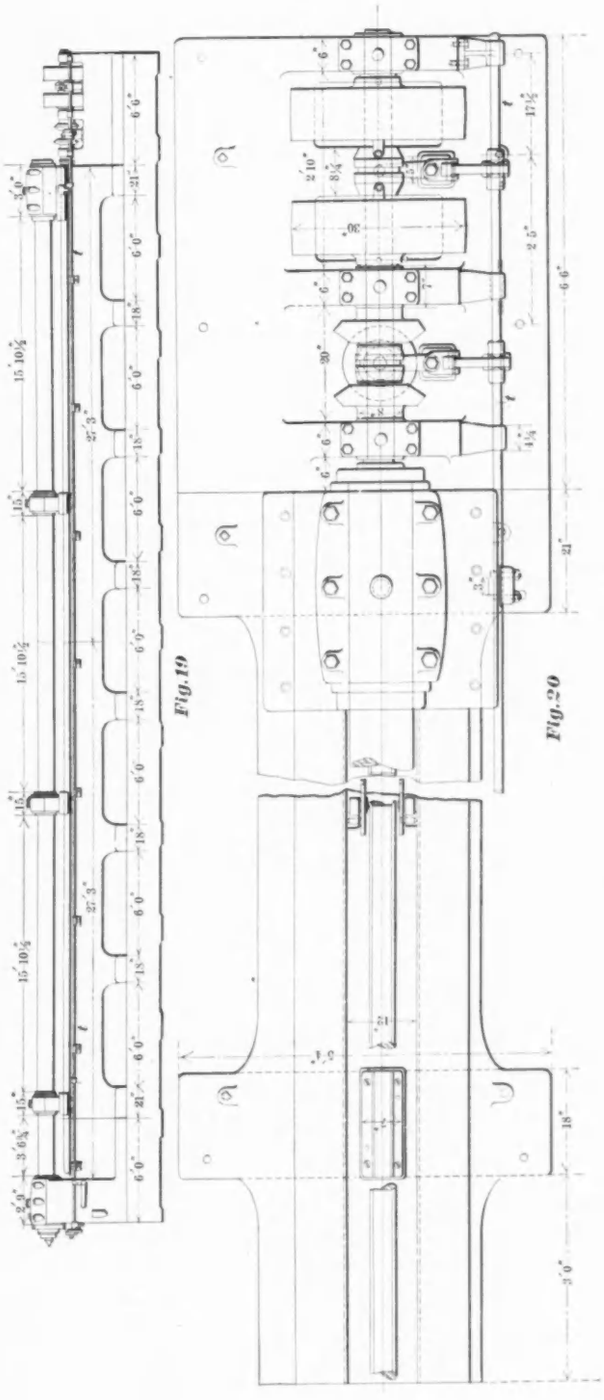


Fig. 19

Fig. 20

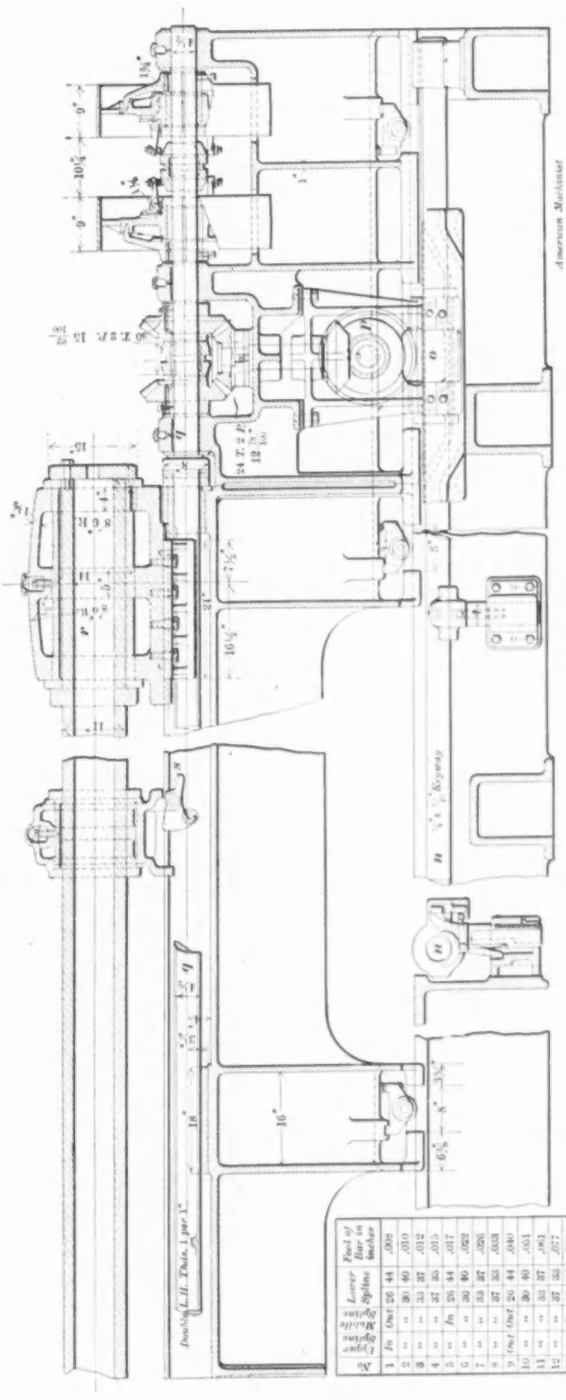


Fig. 21

BORING-BAR AND FEED MECHANISM.

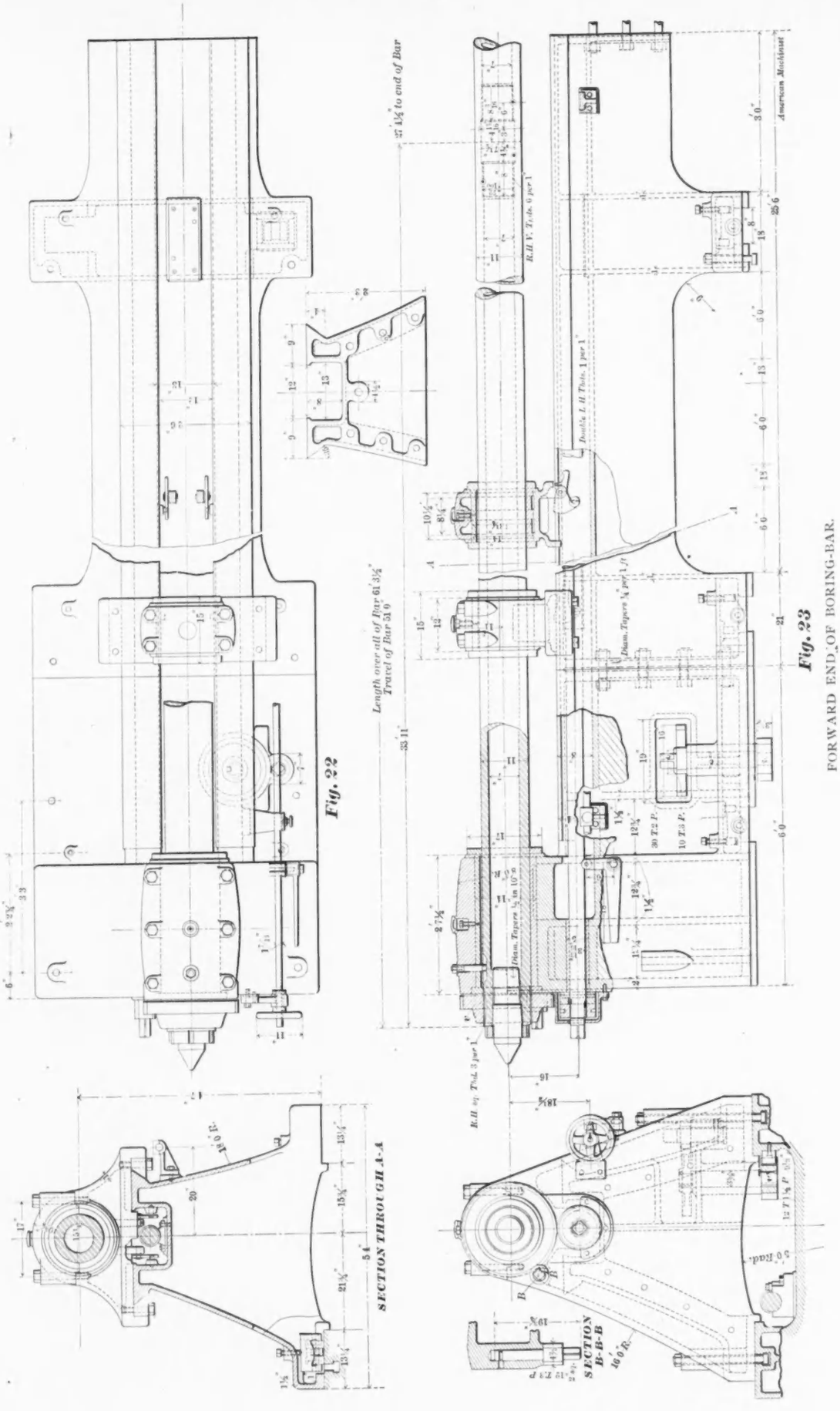


Fig. 22

Fig. 23

FORWARD END OF BORING-BAR.

end of the boring-bar. The support at this end is solid with the boring-bar carriage. As it is sometimes necessary to turn guns upon centers in these lathes, the bar is made to serve the purpose of a tail spindle, and is moved forward or back by hand, by means of a threaded ring *v*, Fig. 23. This is of brass and is threaded directly to the bar with right-hand 3-per-inch threads. Outside it is a gear wheel, and it is rotated by a pinion which is below and to the left of the gear in the end view of Fig. 23; a section still further to the left showing the arrangement of the pinion, the end of whose shaft is also squared for a ratchet wrench. When the bar is moved in this way, the flange at the extreme right-hand end of the bar, shown in Fig. 21, is removed to allow the bar to slide through the bearings.

Fig. 23 also shows the means provided for moving the boring-bar carriage upon the bed, which is by the pinion *w*, which engages with a rack on the bed. In dotted outlines are shown the rollers upon which the carriage is supposed to rest when the binding bolts are released; the set screws, shown bearing on top of the levers, serving to adjust the pressure upon the rollers so that they just support the weight of the carriage, yet allow it to be clamped to the bed by the binding bolts.

THE CENTER RESTS.

The gun, while being bored, and for a good deal of the turning also, rests in three center rests. Two of these are ring rests; the other, which is called the breech rest and is nearest the head-stock, is shown in Figs. 24 and 25. In this rest the gun lies upon a phosphor bronze shoe *x*, which fits into a rectangular opening in the rest and is adjusted by means of the wedge shown, which wedge is moved by the traversing screw shown below it in Fig. 25. As shown at the left of this figure, the end of this screw is squared so that it may be turned directly for rapid adjustment when little or no weight is upon the shoe, and it is also provided with the gearing shown so that it may be moved when the gun is in place. The two forged steel rollers seen above, one on each side, support the gun laterally, and the rest is open at the top. It is moved along the bed by the gearing shown in Fig. 24.

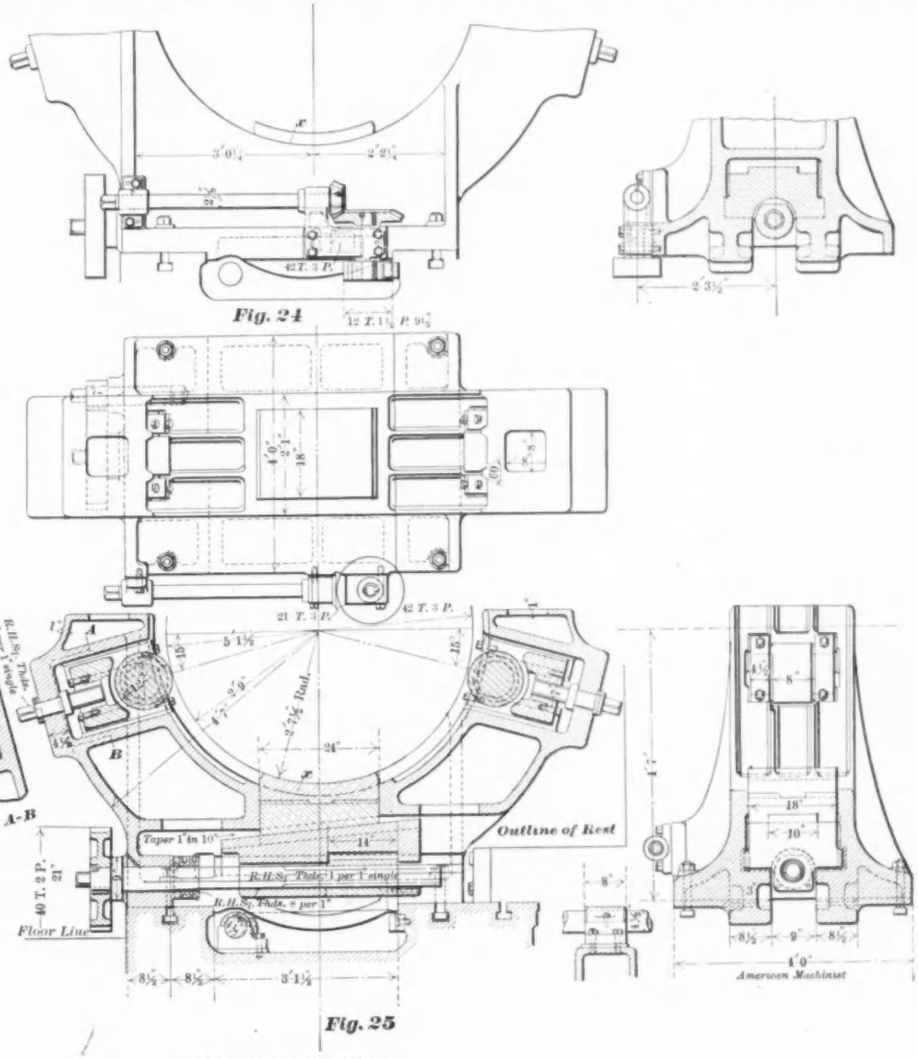


Fig. 24

Fig. 25

THE BREECH REST.

This rest weighs 10 tons. The bronze shoe referred to is 24 inches long and 18 inches wide, while the steel rollers are 12 inches diameter and 17 inches long over all.

The other two rests are very much alike, except that the one at the muzzle of the gun has only one set of jaws, while the other one has two sets, one on each side of the ring. This latter rest is shown in Fig. 26 and will be readily understood from the drawing. The jaws are set down tight upon the gun, and the ring in which the jaws are set revolves with the gun; the seat in which it revolves does not extend entirely around the gun, but only slightly above the center, as shown. This rest has six jaws on each side of the ring, and it weighs, complete, 11 tons.

At this writing the lathe has not yet been set up at Watervliet, but was operated and tested in the shops at Plainfield, where it worked perfectly, all its motions being smooth and easy and under perfect control of the operator. This lathe is one of three similar ones built by the Pond Works for Watervliet, besides twenty-four smaller ones. The lathe shown cost the War Department about $50,000.

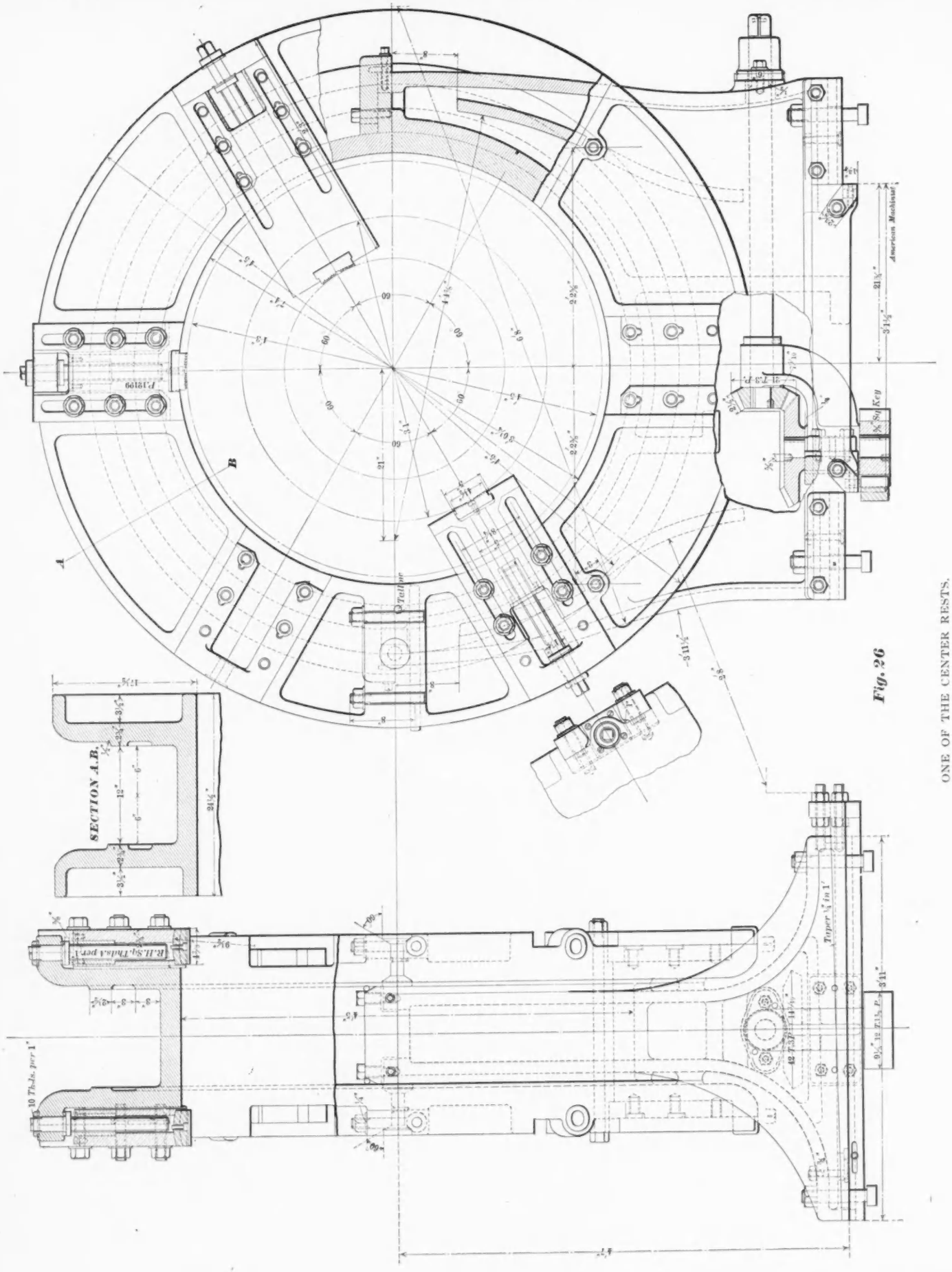


Fig. 26

ONE OF THE CENTER RESTS.

The Practice of the Ordnance Department, U. S. A., in Doing Lathe Work on Heavy Guns.

BY ANTHONY VICTORIN.*

The purpose of lathes of such large proportions as have been designed by the Ordnance Department, U. S. A., and recently built by the Pond Machine Tool Co. for the Army Gun Factory at the Watervliet Arsenal, and the conditions governing the design and the functions of their principal parts, can be properly explained only by describing the more characteristic phases of the work that is to be done in them.

The manufacture of a gun of 12 inches bore, a number of which have been finished during the past years at the Army Gun Factory, is very similar to the construction of 16-inch guns, for which the above lathes are intended; and with the exception of the greater dimensions and the greater weight of the pieces constituting a 16-inch gun, the principles involved in their machinery and assemblage are generally the same.

Most modern guns of large caliber are of the "steel built-up type." The theoretical principles governing the design of guns of this type were laid down by Captain Rogers Birnie, Jr., of the Ordnance Department, United States Army. They are to be found in text-books on Ordnance, as well as in publications of the Ordnance Department. To put this theory into practice means the operations which are at present principally carried on at the Watervliet Arsenal—the finishing and assembling of modern cannons.

A 12-inch steel breech-loading rifle, which is the largest thus far made at Watervliet, comprises eleven parts, all of forged steel, of about 95,000 pounds ultimate strength and about 45,000 pounds elastic limit. These forgings vary in size and weight according to their peculiar individual purposes and positions. The two largest forgings are the tube and the jacket, weighing more than 32,000 pounds each; while the smallest forging, the trunnion hoop, weighs only about 5,000 pounds. The aggregate weight of the eleven pieces forming a 12-inch gun is about 137,000 pounds, and the total weight of the completed gun is about 116,500 pounds. This means the removal of about 20,500 pounds, or of 15 per cent. of the rough weight, during the construction of the gun.

The machine tools and other devices necessary to accomplish the work of finishing and assembling are of considerable magnitude, and their construction must be such as to perform properly and safely the peculiar functions on which depend the methods pursued in gun construction. I say "safely," because the great value of gun material calls for a full exertion of the mind in devising mechanical means to prevent losses. Considering the masses to be machined, it must be stated that the construction of guns of the "built-up" type depends on the shrinkage effects or compressions obtained in assembling the parts. To produce uniformly good guns requires accuracy and uniformity in workmanship; and to obtain this to the greatest possible extent by mechanical devices, means practical perfection and economy.

In beginning the description of the methods employed in finishing and assembling a 12-inch gun, it may be well to recite for comparison the general features of 12-inch and 16-inch guns: The total length of finished 12 and 16-inch guns is about 37 feet and 50 feet, respectively, and the total weight is about 52 and 127 gross tons, respectively, or 116,480 and 284,480 pounds. The latter weight, which is somewhat less than the weight of the assembled gun before finishing, accounts principally for the massive proportions of the principal parts of the 16-inch gun lathes.

The dimensions and weights of the steel forgings required for a 12-inch gun are shown in the accompanying plate (p. 14). These forgings are obtained from the Bethlehem Iron Co. and from the Midvale Steel Co., and they are rough-machined all over when received at the gun factory. The greatest care is given to the production of the material. Only the best part of ingots (50 per cent. of its total weight) is fit for high-power guns. The diameter of the ingots is of importance, because the production of steel forgings of proper quality depends largely on the amount of reduction, or on the relative cross-sections of the ingot and the completed forging. This ratio is prescribed by the Chief of Ordnance. Such forgings, when produced solid, are bored out subsequently, but they are now almost exclusively forged on mandrels, the ingot having been pierced previously in a lathe.

Steam hammers and hydraulic presses are employed in the forging process, and the forgings are subsequently reduced by turning and boring processes to dimensions fixed by the Chief of Ordnance. They are then annealed and oil-tempered. When brought to this state they are ready for delivery to the gun factory, providing careful tests prove that the product is of the required physical quality; the requirements in this respect being also prescribed by the Chief of Ordnance.

In finishing the parts constituting a gun, they are first prepared for shrinkage or assemblage. The tube, which is a very long and slender piece, is frequently warped. Before commencing any turning or boring operations on this piece, its approximation to straightness is ascertained by means of a tell-tale, and its original axis is thrown as much as necessary to make it "clean up" and bring it to the required dimensions preparatory to shrinkage. This is done by adjusting one end in the chuck jaws of the face plate, while the other end is put on the tail center by means of a special center chuck, which is a flanged casting with steel center. The flange is provided with a number of set screws for the adjustment of the end of the tube. The tube is now said to be "on centers." No intermediate supports are used. Centering spots, from 1 to 2 inches in width, are turned on the exterior of the tube. These are reference spots during subsequent turning and boring operations. The interior of that end of the tube which is furthest from the face plate is also spotted concentric with the former spots. In doing this, the tube is supported in the face-plate chuck at one end. A few feet from the rear or free end, also in the middle, it is supported in back rests. All back rests on recently constructed gun lathes of the Army Gun Factory are of the revolving type, and consist of a heavy housing and a chuck ring. The housings of the back rests belonging to a lathe are bored out true with the main spindle of that lathe, while the exterior running surfaces of the chuck rings are turned true on the face plate of the lathe.. These back rests are therefore short, hollow spindles, and permit the work to be easily brought and kept in alignment with the main spindle.

The tube, supported as described, is now spotted internally for a depth of about 6 inches, by means of an overhanging tool bar supported on the carriage. This counterbore serves as a guide for the body of the first boring tool, and has a diameter of 11.5 inches. The first boring tool is a so-called "hog-nose bit," and is shown in the photograph, Fig. 1 (p. 15). It consists of a cast-iron boring head, spoon-shaped, of a diameter to fit the spotting in the end of the tube. Its length equals 3 to 4 diameters. The rear part of the head is provided with a taper shank, fitting the taper socket in the forward end of the steel boring bar, to which it is rigidly secured by means of a taper key. The forward end of the boring head is fitted with a steel cutter (hog-nose bit) of self-hardening steel. The cutting edge of this tool is nearly entirely forward, and only a small amount of it, which must be in excess of the feed used, is carried around the corner to the side. The width of the forward cutting edge depends on the depth of the cut, or on the amount of metal to be removed on a side, but is usually considerably in excess of it. A tool of this description takes its cut forward, and permits of boring a straight hole under the existing conditions. It must be remembered that the tube forging is almost invariably more or less sprung, and that, consequently, the whole amount of metal to be removed by the hog-nose, which ought to be 0.25 of an inch all around with a perfectly straight tube, may be sometimes nearly altogether on one side (0.5 of an inch), and only a few hundreds may be on the other side. It is clear that a side tool would be easily

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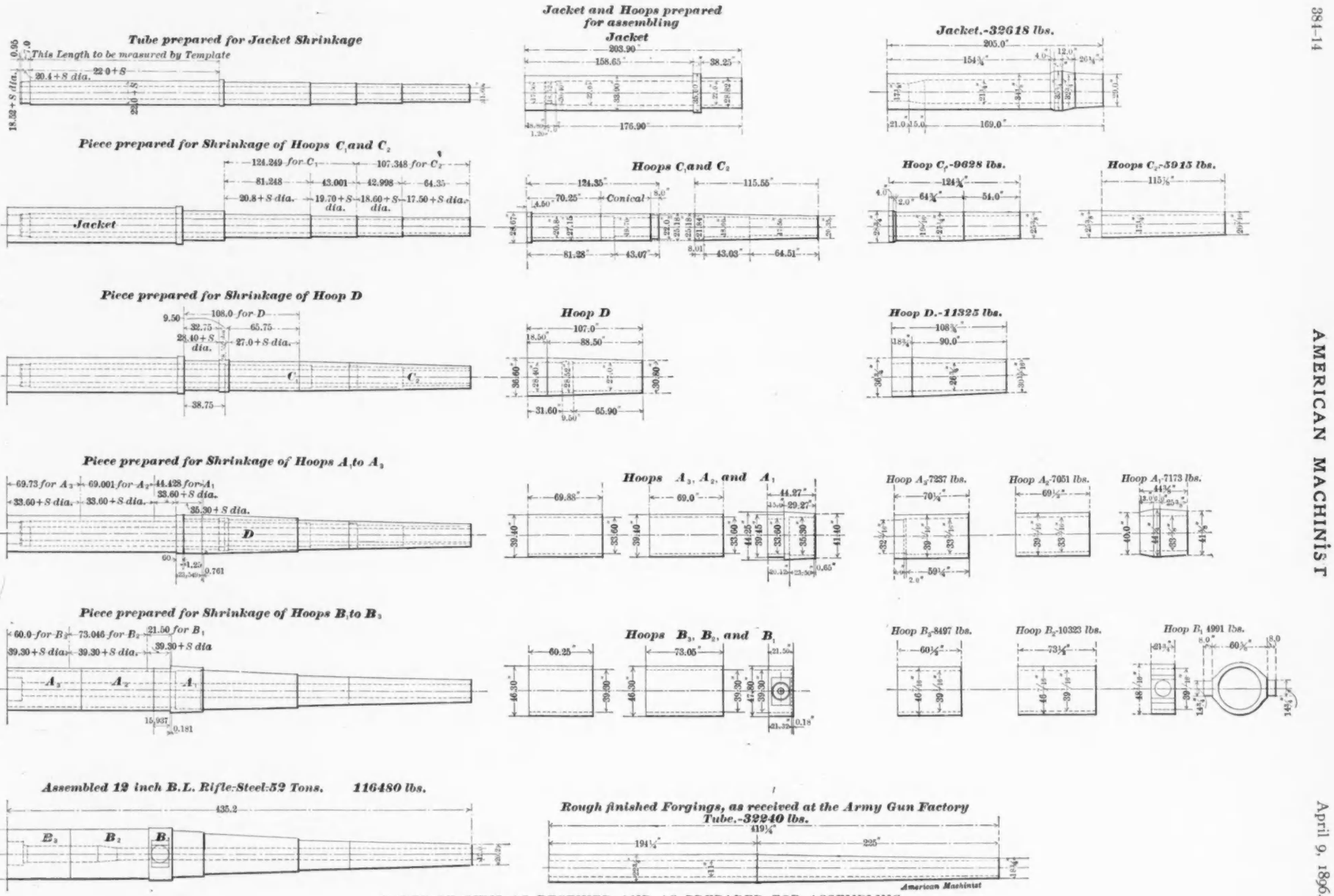


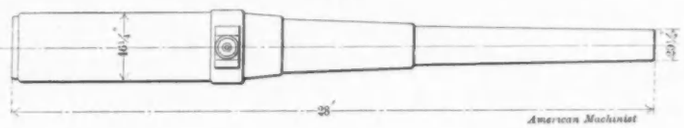
PARTS OF GUNS AS RECEIVED AND AS PREPARED FOR ASSEMBLING.

deflected from the straight course under such conditions.

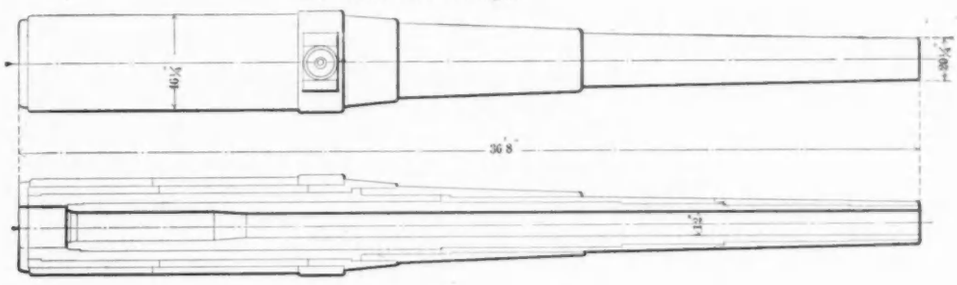
Everything being prepared for boring, the boring head is carefully entered into the counterbore, and the lathe is put in operation. The cutting speed is 6 feet per minute, and the feed or tool advance per revolution of the tube is about 0.04 of an inch. Feed and cutting speed depend largely on the character of the gun steel. Under favorable conditions of the tool, uniformly soft gun steel will permit a cutting speed of 9 feet per minute with a tool advance of 0.08 of an inch. Such results were obtained in special instances, but experience has shown that it is detrimental to force the work to that extent. There are hardly two tubes of the same hardness, and not infrequently local variations in the hardness of the metal of the same piece will be observed. Dullness and brittleness of the cutting tool is another reason for caution. All these considerations, combined with the occasional change of operators, lead logically to the adoption of arbitrary moderate speeds and feeds, in order to obtain, without too much trouble, safely, uniform good results. The cutting edge of the tool is slightly above the horizontal plane.

Lard oil is used for lubricating the cut-

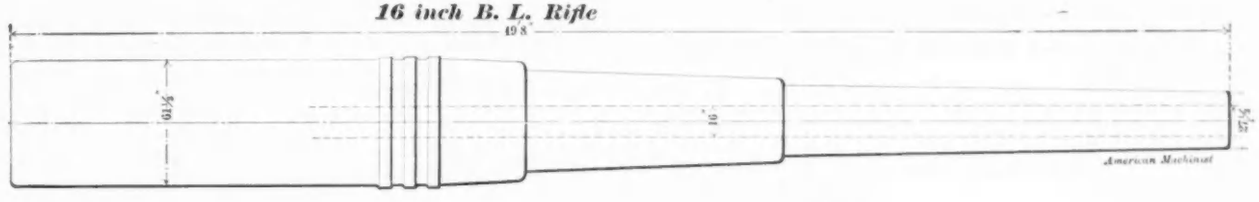
10 inch B.L. Rifle



12 inch B. L. Rifle



16 inch B. L. Rifle



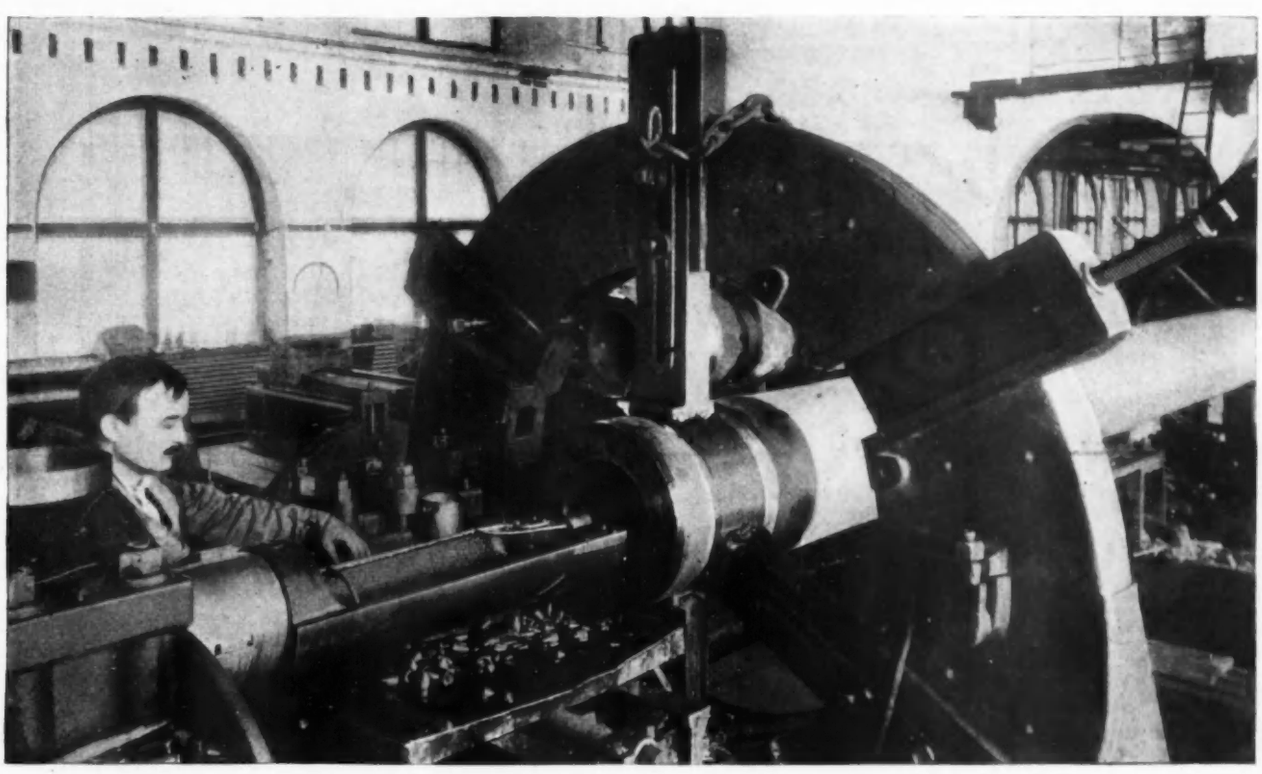


Fig. 1. HOG-NOSE TOOL BORING 12-INCH TUBE.

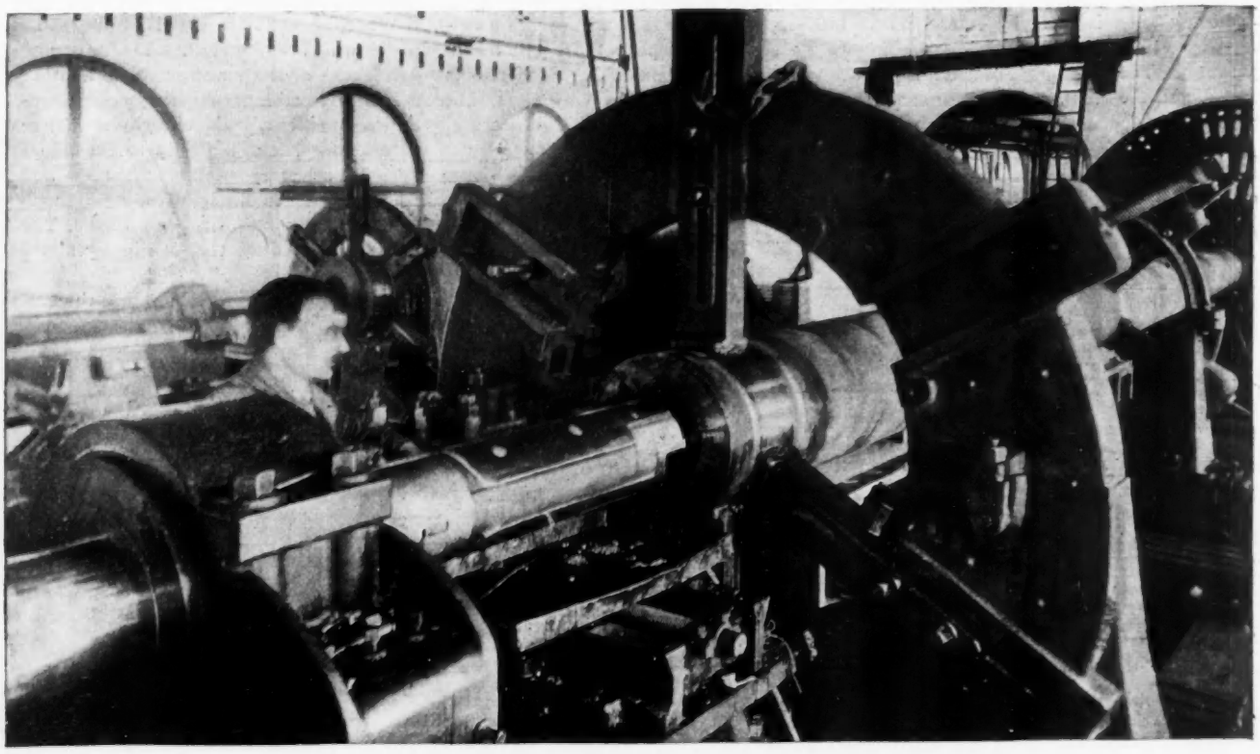


Fig. 2 WOOD REAMER REAMING 12-INCH TUBE.

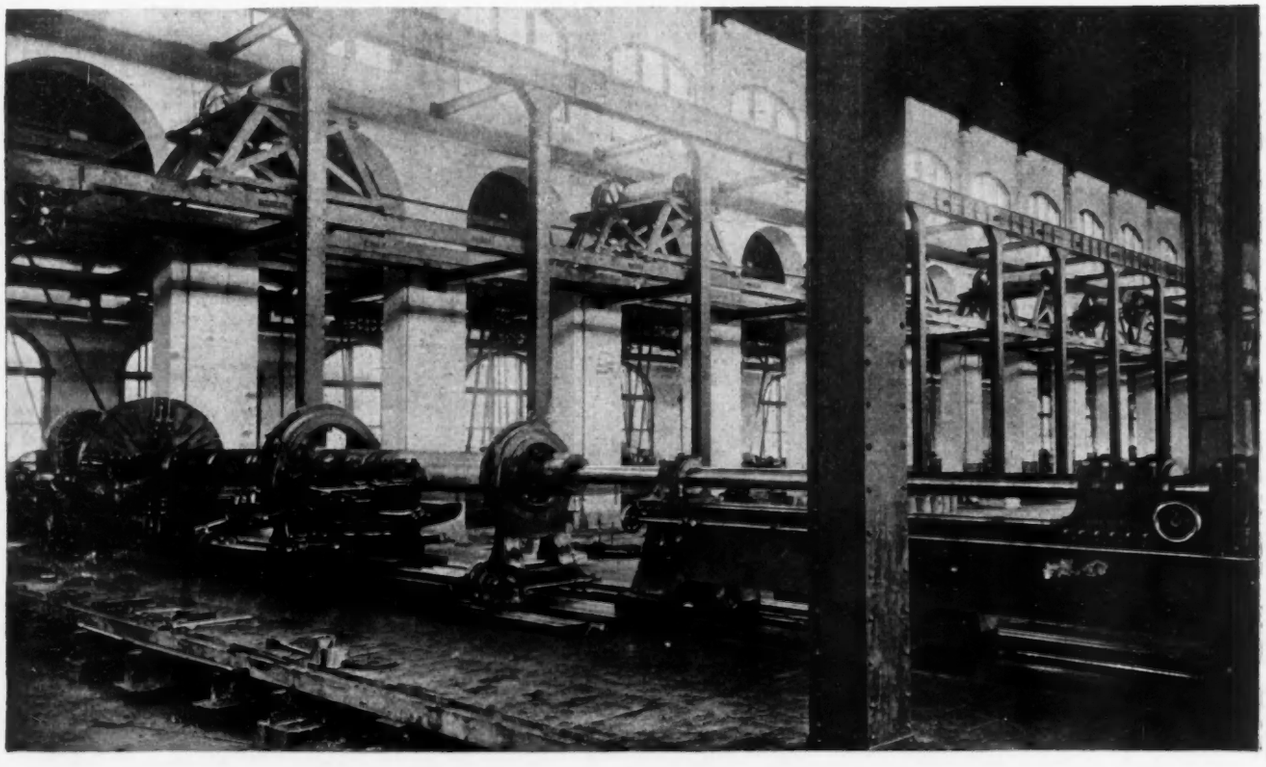


Fig. 3. BORING AND TURNING A TUBE SIMULTANEOUSLY.

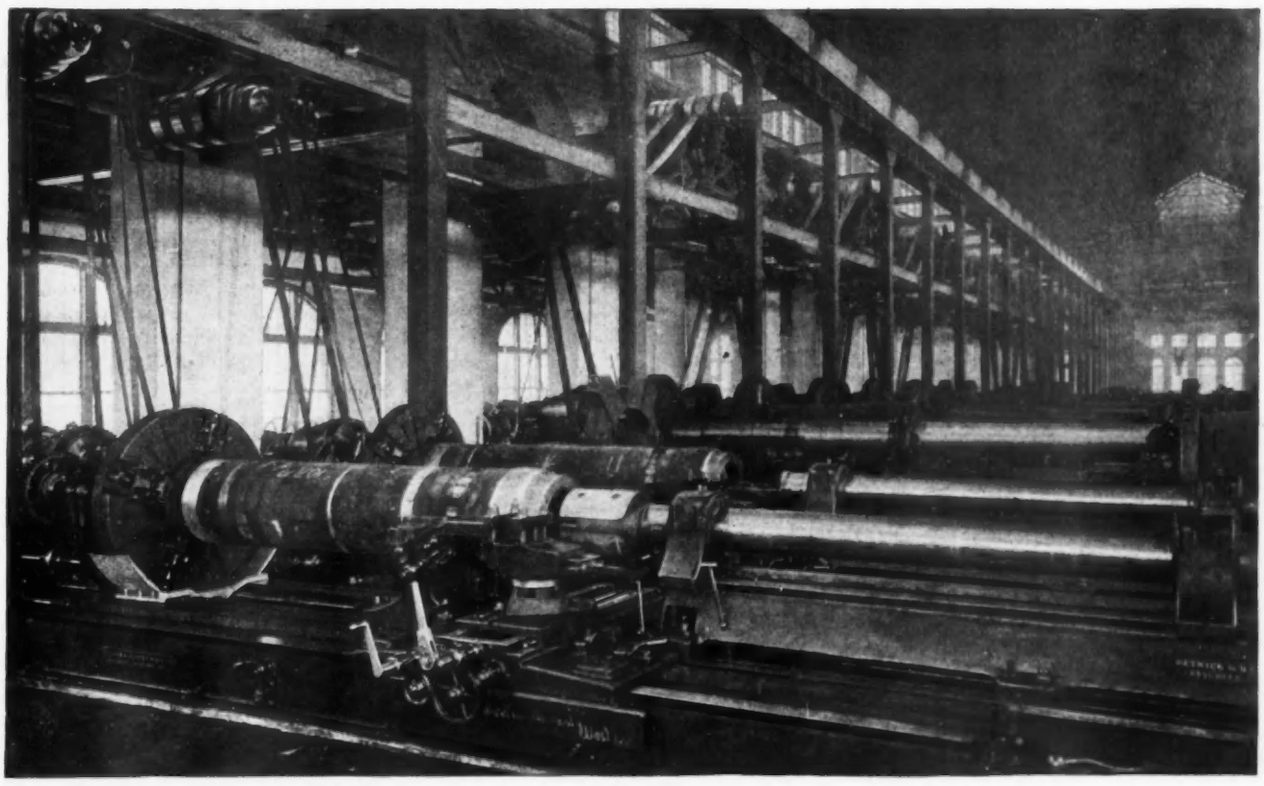


Fig. 4. JACKET LATHES FOR 8-INCH AND 10-INCH GUNS—HOG-NOSE AND WOOD REAMERS

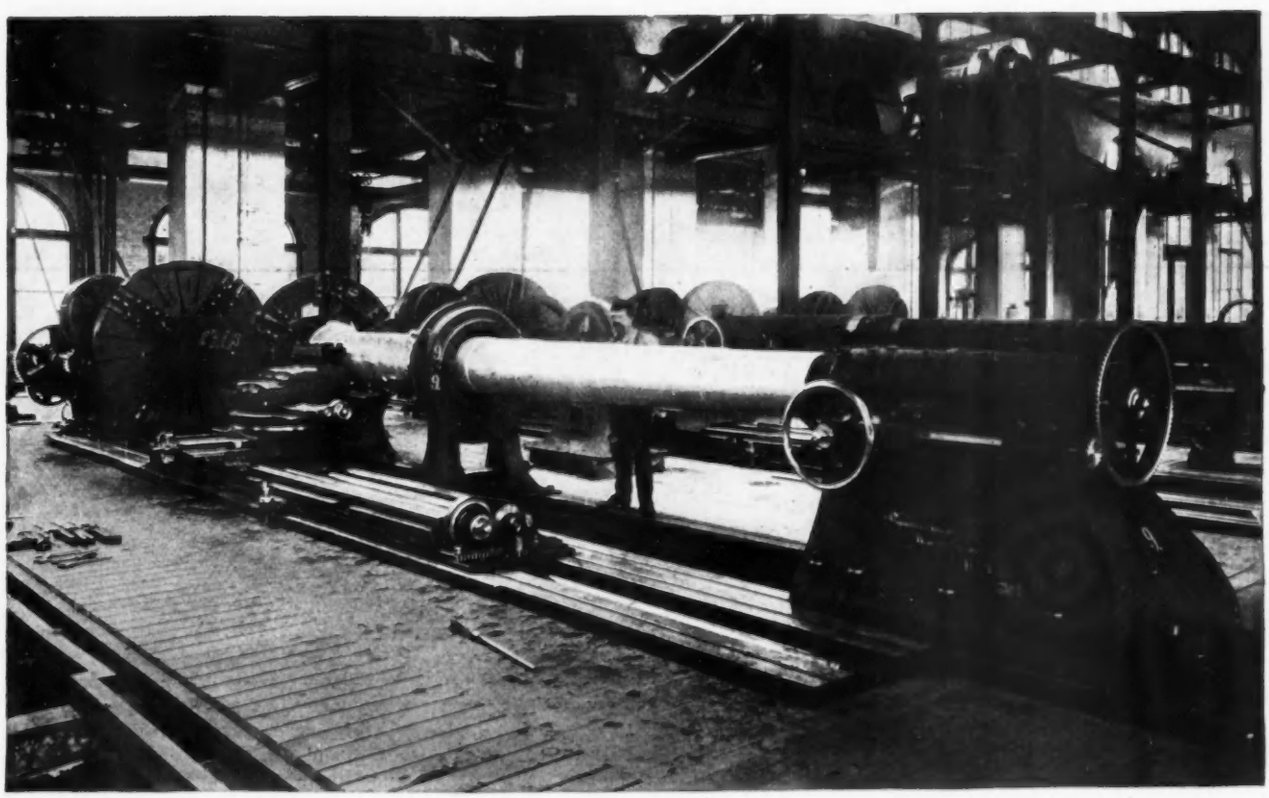


Fig. 5. TURNING SHRINKAGE SURFACES ON CHASE OF 12-INCH TUBE FOR "C" HOOPS.

ter; the oil supply is automatic, by means of a small rotary pump which is attached to the head stock. The oil reservoir is located immediately beneath the face plate of the lathe, and the pump forces the oil through a system of pipes, the last of which passes through the hollow-steel boring bar and connects with an oil passage in the boring head. A small copper tube conveys the oil finally toward the tool. The oil thus discharged passes through the bore of the tube and facilitates the passage of the borings or chips in the same direction. Oil and chips fall ultimately into a tray or sieve on top of the oil reservoir. The lubricant is thus in circulation. A part of the oil circuit must be of a flexible nature to acommodate the rear or driving pedestal of the boring bar. Rubber tubes, which were originally applied, caused expense and inconvenience. A rubber tube seldom lasted for more than a few boring operations before its deterioration caused trouble. "Almond's" flexible metallic tube replaced the rubber tube with excellent results, and for four years has been exclusively used in the Army Gun Factory for flexible oil conduits.

The character of the borings is constantly observed. Breakage or dullness of the edge of the tool is readily indicated by the nature of the borings. If such is observed, the cutter head is withdrawn from the bore for examination. If found to be cracked or dull, the tool must be replaced or reground, or stoned, before the operation can be continued. A rapid traverse of the boring bar (about 15 feet per minute) is provided in the mechanism of the gun lathe, for the purpose of withdrawing or re-entering the boring tool.

The nog-nose tool, while producing a practically straight bore (as a rule, it will not "run" over 0.1 of an inch), does not produce the necessary uniformity of the diameter of the bore throughout its length. A second boring operation follows the first one, to eliminate the abovenamed irregularities by means of a "wood reamer," Fig. 2 (p. 16). This consists of a cast-iron cutter head, lagged with maple wood, of a length equal to from 3 to 4 diameters. The maple wood must be soaked in oil for weeks before it is used, to avoid its swelling in the bore, during the daily periods when the lathe is standing still. Two cutters are attached to the forward end of the head. They are arranged diametrically opposite in the horizontal plane, and their cutting edges are about $\frac{1}{10}$ of an inch above and below this plane, respectively. The provisions for securing this boring head to the boring bar are identical with those of the hog-nose. It may be necessary to readjust the tube in the lathe in case of a considerable run of the hog-nose tool, before beginning operation with the wood reamer. It is also necessary to prepare a counterbore at the rear end of the tube, to receive and guide the boring head at the beginning. This counterbore is 11.6 inches in diameter and about 6 inches in length, and the exterior of the reamer is turned off to suit this bore. Under normal conditions the wood reamer will therefore enlarge the bore 0.05 of an inch on a side, using a cutting speed of 6 feet per minute and a feed of about 0.1 of an inch per revolution. The cutting edge of the tool is entirely on the side, and is about 3 inches long. The forward part of it (about 1¼ inches in length) is taper, and this part removes the stock. The remainder of the cutting edge is parallel to the axis of the bore. The proportions of the cutters are such as to combine keenness with great strength. A stream of oil is directed toward each cutter. The remarks relative to oil circulation, observation of borings, examination and correction of the cutter, etc., made in describing the working of the hog-nose, apply here also.

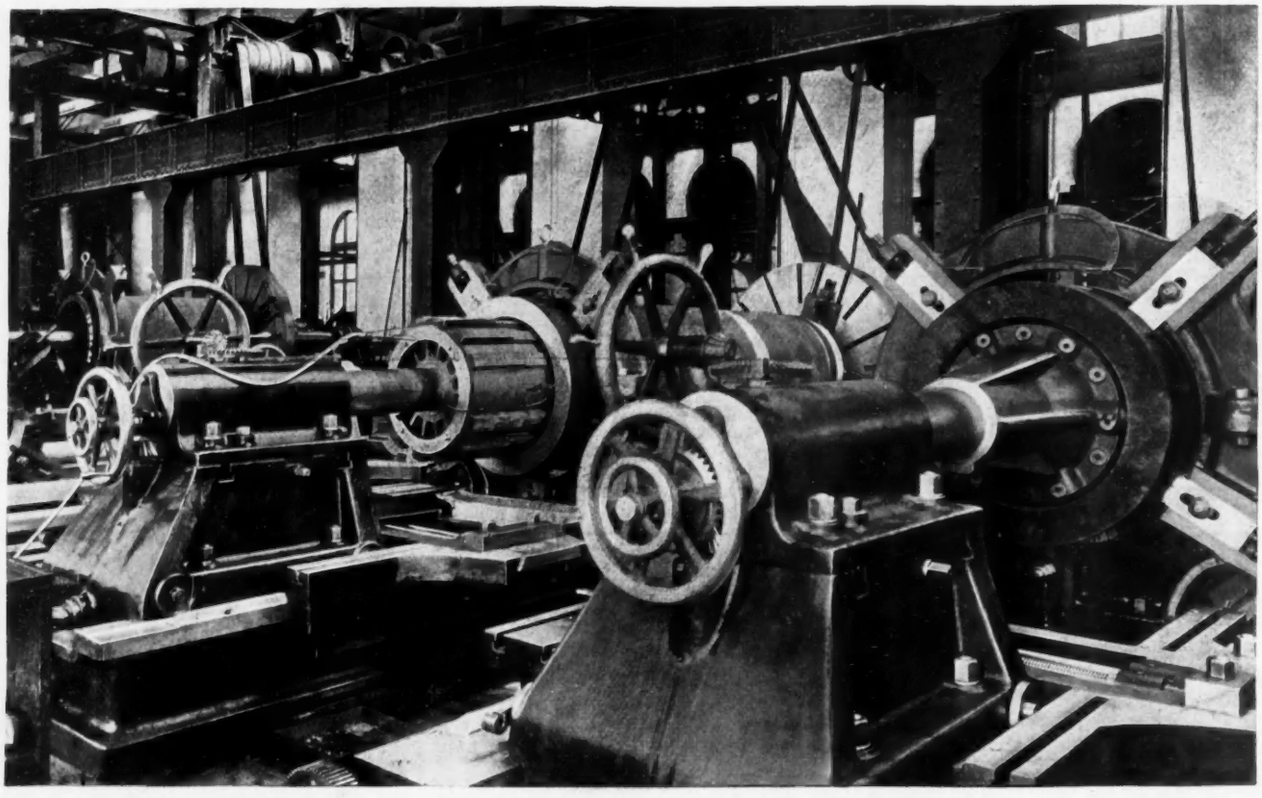


Fig. 6. ROUGH AND FINISH BORING OF 12-INCH GUN HOOPS.

The preparation of the bore of the tube previous to shrinkage operations has thus been described. But the exterior must be finished also, or turned, to dimensions shown in the accompanying plate, in order to prepare the tube for the reception of the jacket. The mechanism of the gun lathes permits of carrying on turning and boring operation simultaneously. No turning is done during the operation of the hog-nose tool, as this may affect the desired result; but turning is carried on simultaneously during the passage of the wood reamer, with the precaution that the boring and turning tools are at least 5 feet apart longitudinally. In turning the exterior of the tube, about ⅜ of an inch of

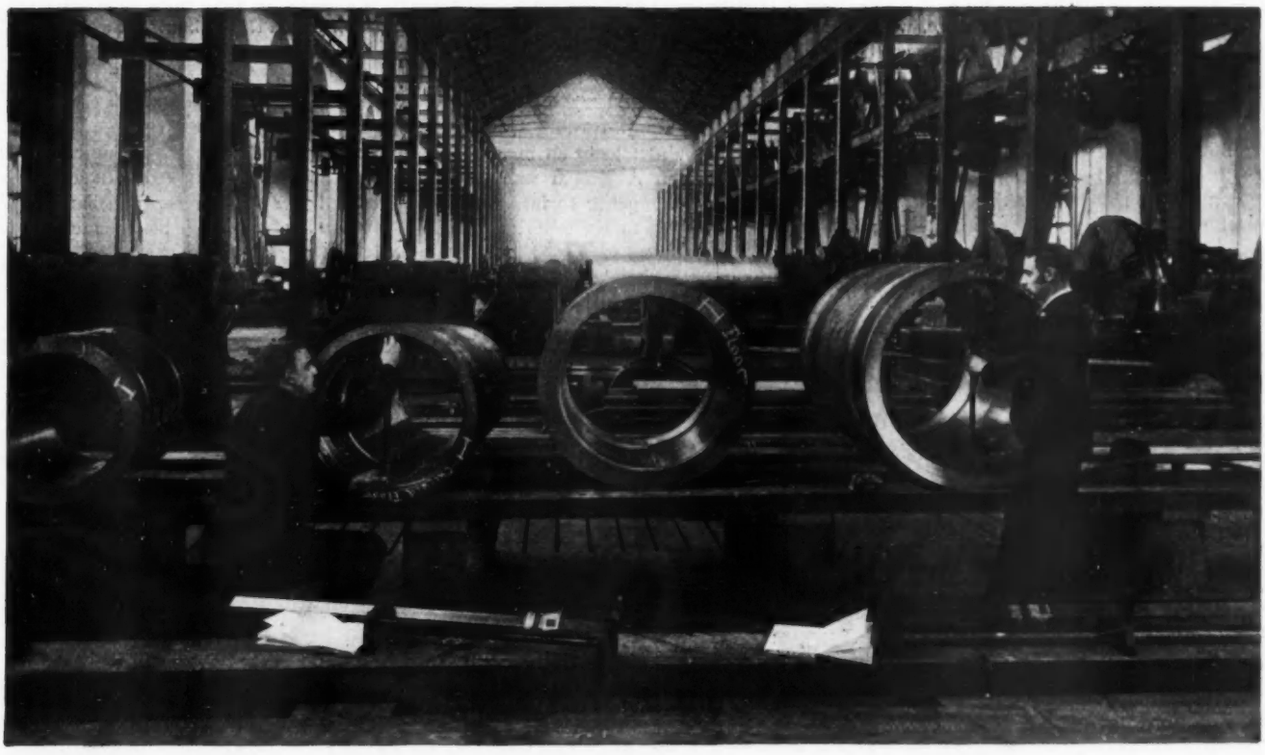


Fig. 7 MEASURING SHRINKAGE SURFACES OF HOOPS BY MEANS OF POINTS.

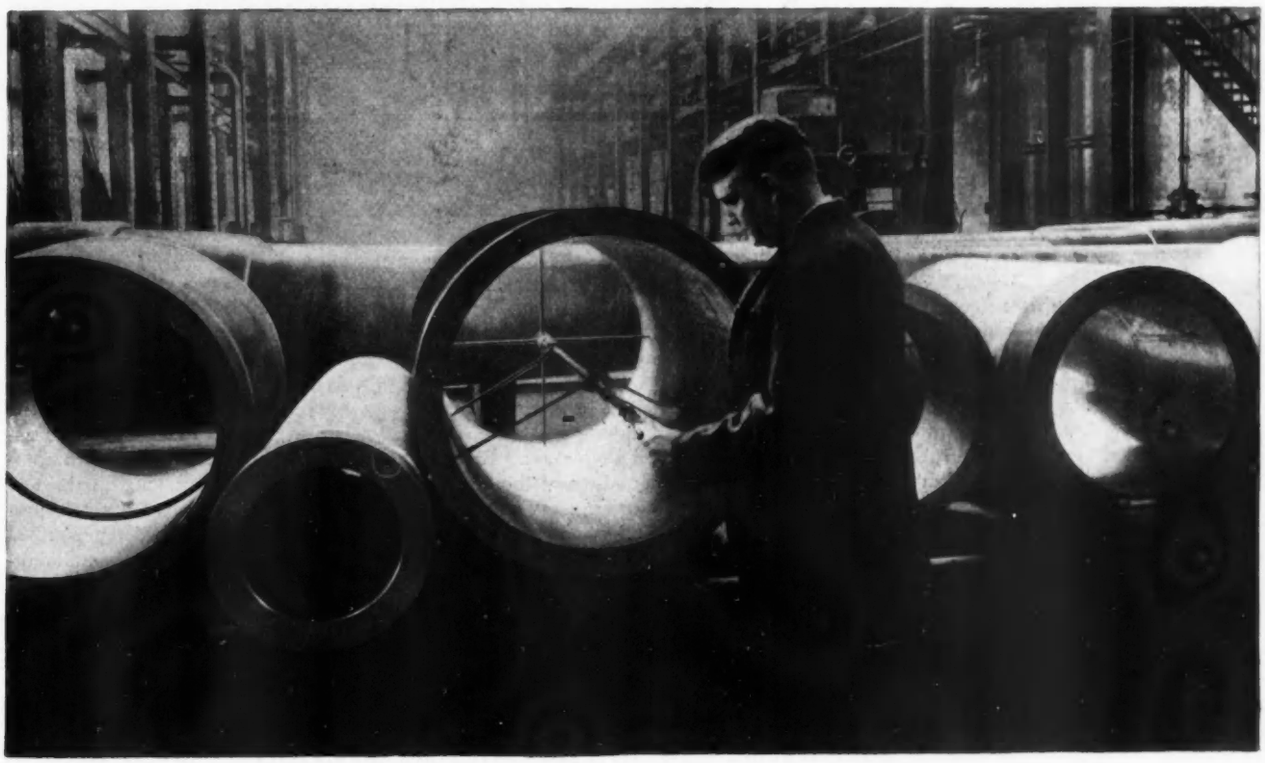


Fig. 8. STAR GAGE FOR MEASURING SURFACES OF HOOPS.

stock is removed on a side on the seat for the jacket, and about $\frac{5}{8}$ of an inch (mean) on a side on that part which is to receive the two *C*-hoops. The seat for the jacket is completely finished at this stage, while the seat for the *C*-hoops is only roughed out to within $\frac{1}{32}$ of an inch of the shrinkage diameter, as a precaution, because the jacket which is shrunk on first may cause a slight warping of the slender forward portion of the tube.

It may be properly stated here that the machining of long and large bores is subject to certain difficulties, while the turning of the surfaces can be carried on with great accuracy by a reliable and skilled mechanic. It is for this reason that all bores of the parts constituting a gun are finished before their corresponding shrinkage surfaces are turned, and it is consequently obvious that the jacket must be finished for assemblage before turning its seat on the tube. Jackets are turned and bored and thus prepared for assemblage, at the Army Gun Factory, in lathes of similar nature to gun lathes; but the jacket lathes are much smaller machines, and therefore more economical as regards installation and operation.

The processes of devices applied in boring and turning jackets, Fig. 4 (p. 17), are identical with those used in the preparation of tubes. A hog-nose tool enlarges the diameter of the rough bore from 21.25 inches to 29.9 inches, while a wood reamer finishes the bore to a diameter of 22.0 inches. The cutting speed is 6 feet per minute in each case, and the feed of the hog-nose is 0.04 of an inch and that of the wood reamer 0.06 of an inch per revolution. The exterior of the jacket is only roughed out before assemblage. It is finish-turned previous to assembling the *A*-row of hoops at a later stage of the construction. In rough-turning (previous to assembling), about $\frac{1}{8}$ of an inch is removed on a side. A similar amount is removed in preparing the shrinkage surface for the *A*-hoops on the exterior of the jacket.

In preparing a shrinkage surface, the piece is first rough-turned over its entire length to within about 0.03 of an inch of the shrinkage diameter. Two or three tools are employed simultaneously for this purpose (according to the amount of stock to be removed), at a cutting speed of about 8 feet per minute and a feed of 0.05 of an inch per revolution. Either diamond-point or round-nosed tools may be used. In finish-turning, several tools may be used; but the last one must be in a separate slide from the others, so as to have independent adjustment to and from the work. This tool has a square nose. In finish-turning, a cutting speed of about 8 feet per minute is used with a feed of about 0.25 of an inch.

Returning now to that stage of the construction at which the exterior of the tube is to be prepared for assembling the jacket, it must be said that the exact diameter of the shrinkage surface on the tube depends, first, on the diameter of the bore of the jacket, and, second, on the shrinkage—on which last depends the amount of compression which the jacket must exert upon the tube. The compressions and shrinkages are prescribed for every part of the gun, and the greatest amount of care must be observed to obtain shrinkage surfaces of the necessary accuracy. In no case are greater variations than 0.003 of an inch permitted from the prescribed diameters. The amount of shrinkage between tube and jackets of a 12-inch gun is about $\frac{1}{100}$ of an inch per lineal foot of diameter. The mean shrinkage for all the different parts is about $\frac{15}{1000}$ of an inch per lineal foot of diameter.

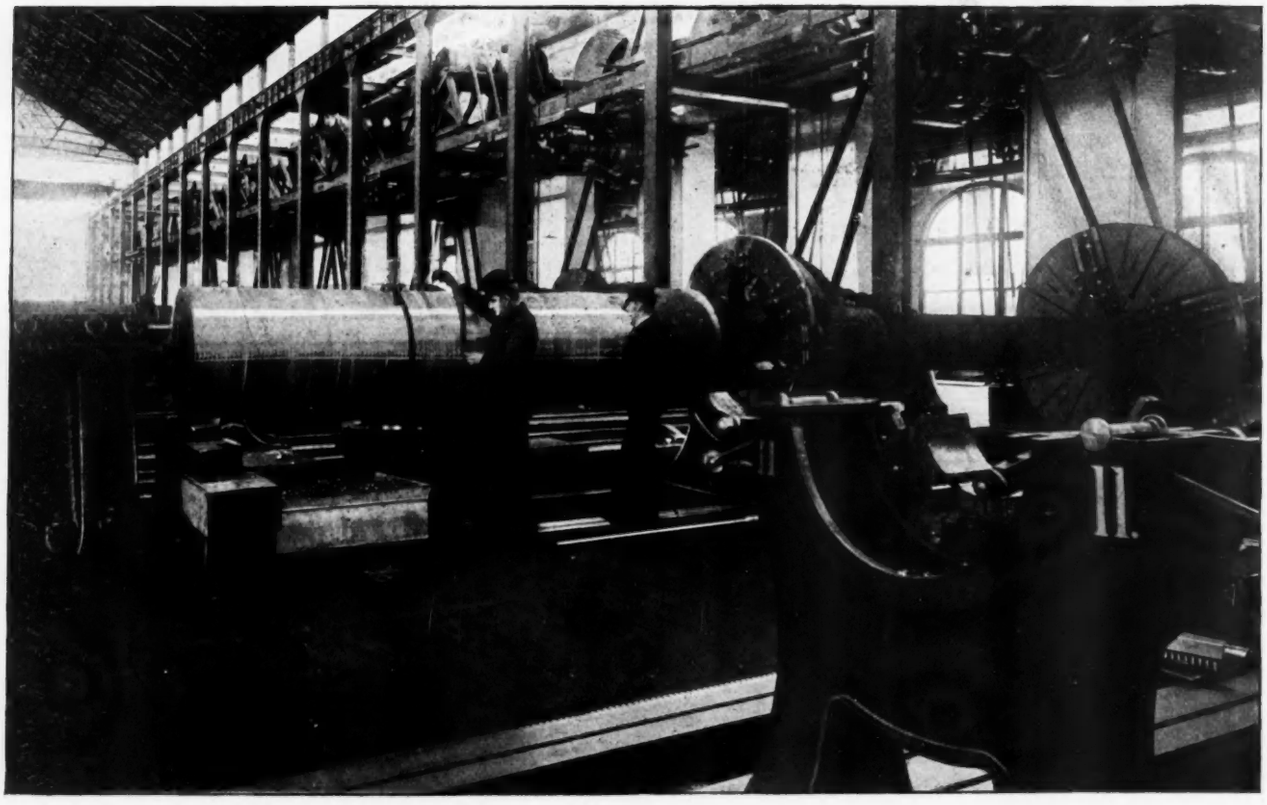
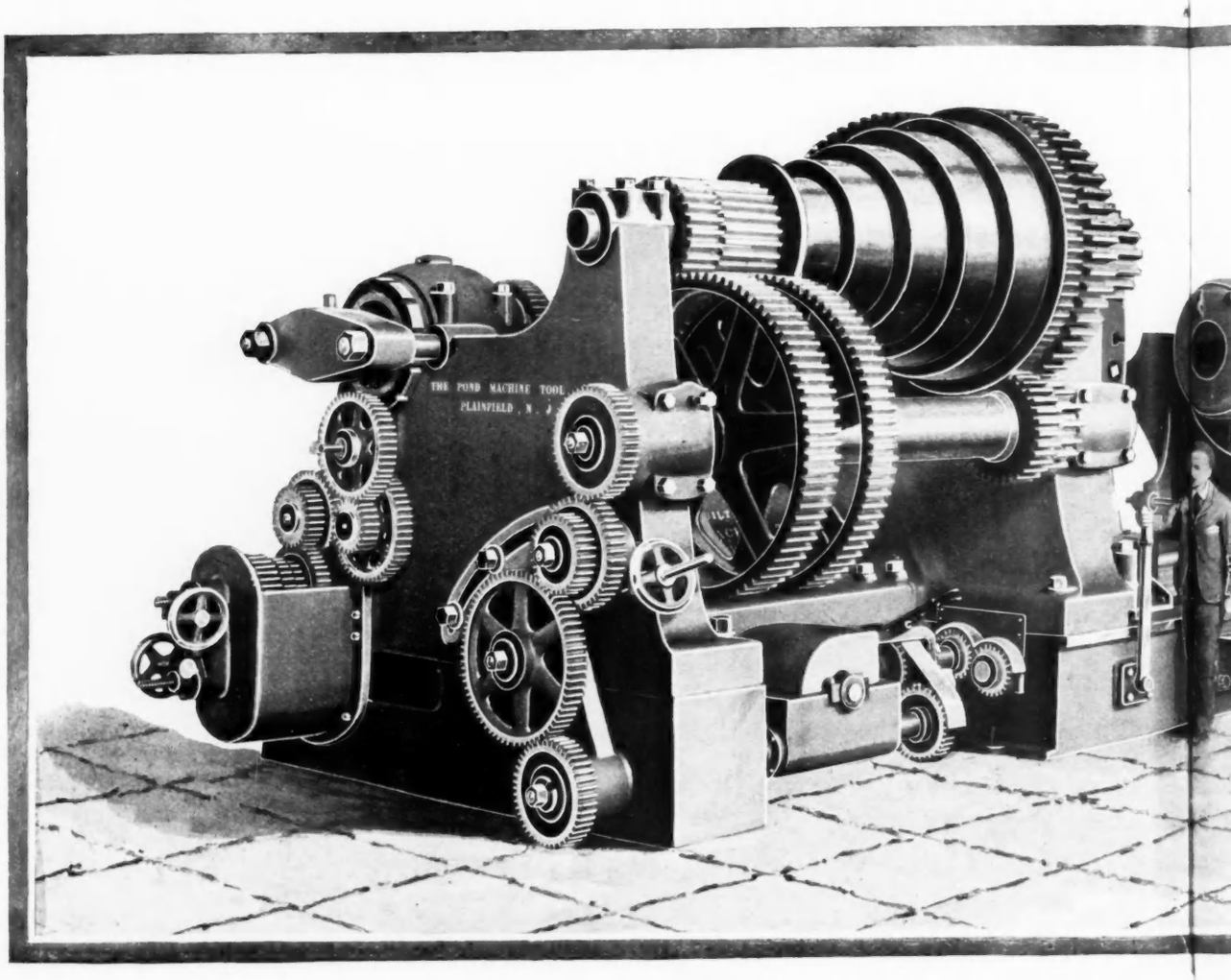


Fig. 9. MEASURING SHRINKAGE SURFACES ON BREECH OF 12-INCH GUN FOR EXTERIOR LAYER OF HOOPS.

The bore of the tube is measured in intervals of an inch, by means of a star gage, previous to the assemblage of the jacket or any other piece. These measurements are recorded and serve to compare the actual compressions obtained in assembling a layer, or even a single part of the construction, with the prescribed ones, during the progress of the building-up process.

The jacket having been shrunk on the tube, the gun is put into the lathe (Fig. 5, p. 17) for finish-turning the shrinkage surfaces for the two *C*-hoops, after which these hoops are assembled.

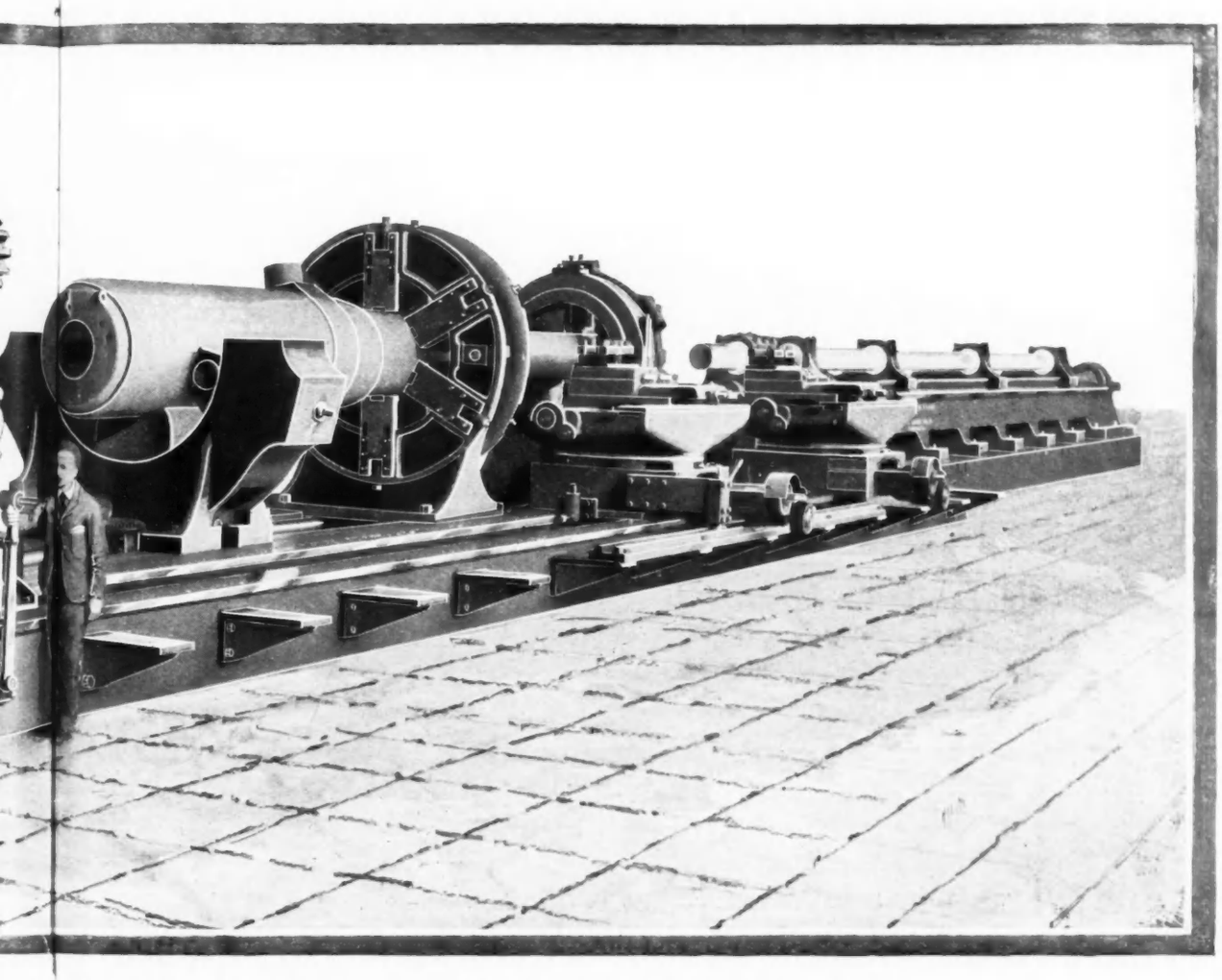
Hoops of great length, like those for a 12-inch gun, are prepared for shrinkage in the following manner: The hoops are



LATHE FOR TURNING AND BORING 16-INCH

Total Length, 138 Feet. Weight (fi

DESIGNED BY THE ORDNANCE



6-INCH RIFLES AT WATERVLIET ARSENAL,

. Weight (finished), 560,000 Pounds.

ORDNANCE DEPARTMENT, U. S. A.

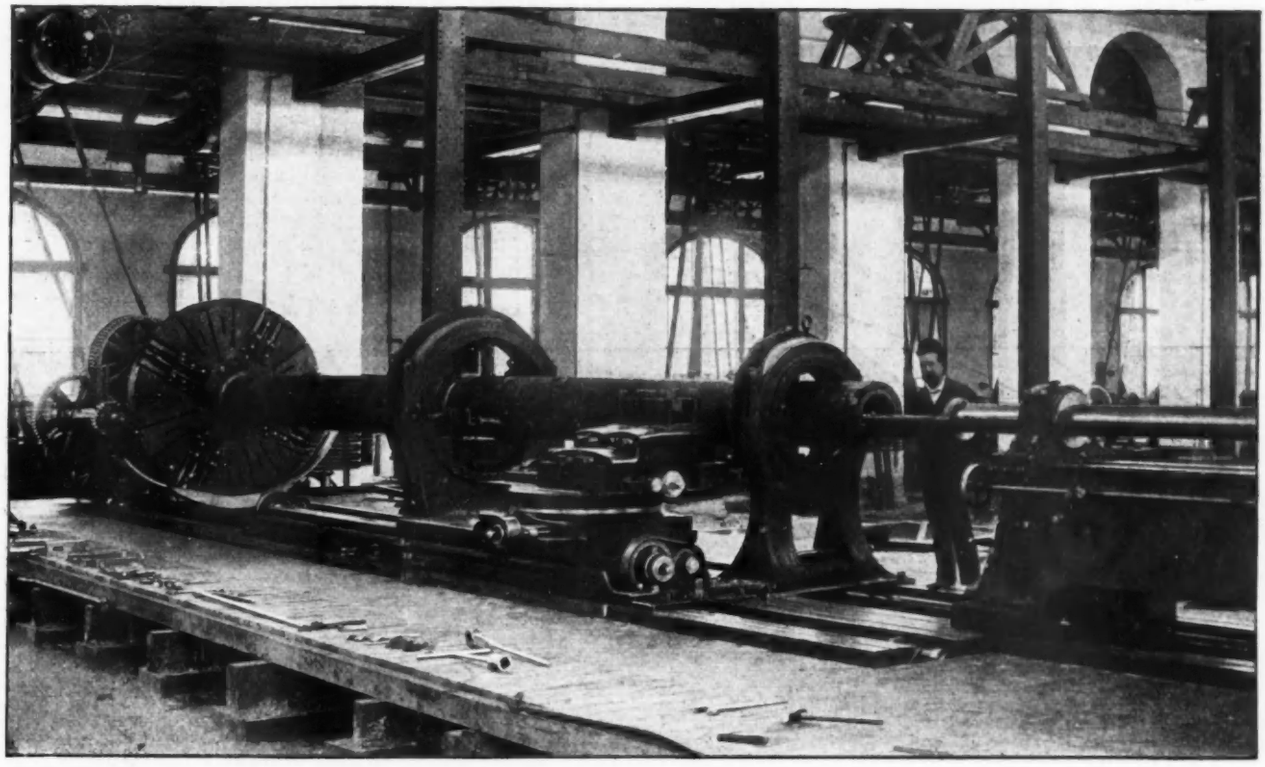


Fig. 10. HOG-NOSE BORING OF 12-INCH GUN TUBE.

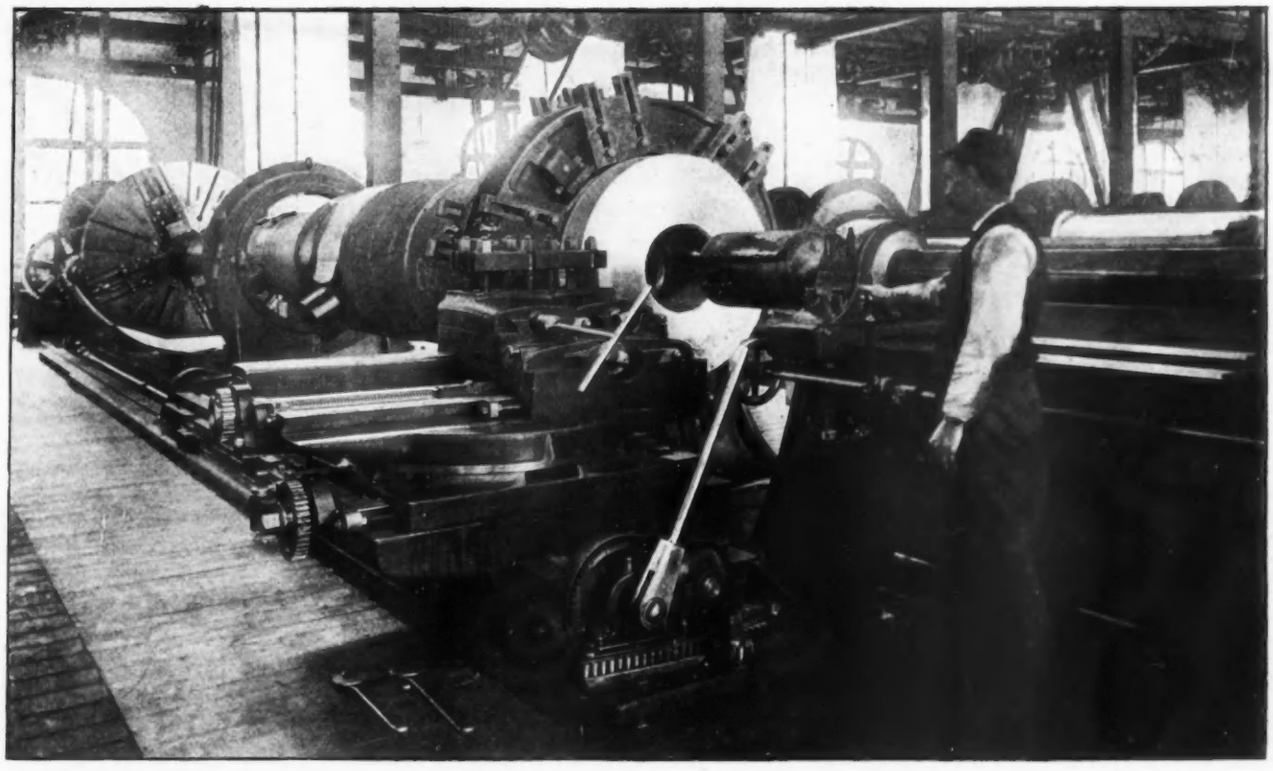


Fig. 11. WOOD REAMER FOR POWDER CHAMBER OF 12-INCH GUN.

adjusted in a hoop lathe, and reference spottings are turned on its exterior (as shown in left-hand portion of Fig. 6, p.18) for subsequent centering operations. The hoop is next rough-bored by means of a cutter head which slides on a boring bar, and which is somewhat smaller in size than the bore of the hoops. This is shown in the right-hand portion of Fig. 6. This cutter head carries two tools in the horizontal plane, and the hoop is bored out to within 0.05 of an inch of the finished diameter, using a cutting speed of about 6 feet per minute and a feed of 0.04 of an inch per revolution. The amount of stock removed on a side by this operation varies from about 0.1 of an inch to about 0.75 of an inch.

For finishing the bore, a wood reamer of special design is employed, which is shown in the central portion of Fig. 6.* It consists of a cast-iron body or skeleton head having a number of wedge-shaped and dovetailed pockets on its circumference, into which the wood packings are tightly fitted. This head is fitted on the boring bar by means of adjustable split bushings. It carries two cutters in the horizontal plane, which are of similar form as those described with the wood reamer for boring tubes. This skeleton head possesses the advantage of greater lightness and economy, and rapidity in fitting it up when using it for different diameters in succession. The usual cutting speed of 6 feet per minute is used with this wood reamer. The feed is about 0.06 of an inch; the amount of metal removed on a side is 0.025 of an inch.

It is advisable to rough-turn long hoops before shrinkage, in order to reduce as far as practicable the tendency of warping in assembling, which is in some degree due to the presence of initial strains in the piece. Short hoops can be bored with sufficient accuracy without the use of wood reamers, and their exterior surface need not be rough-turned preparatory to assembling. The tool carriage is used for squaring off the ends of hoops.

Some hoops have counterbores. The shoulders at the junction of the two diameters are generally finished by means of a stepped wood reamer, provided with special cutters of the exact form of the shoulder, and the particular construction is shown in Fig. 6.

The finished bores of hoops are verified by means of measuring points (Fig. 7, p. 19), or by means of a star gage (Fig. 8). Their length is measured by means of a vernier. The shrinkage surfaces on tubes or partly assembled guns are measured by means of calipers (Fig. 9, p. 20).

The gun, while being assembled, goes from the gun lathe to the shrinkage pit and back again a number of times, until all the pieces are shrunk in place and the turning is done, as shown in Fig. 10. After that begins the process of finishing the exterior, as well as the interior. In finishing the exterior, considerable stock must be removed in forming the rounded shoulders; while on the straight surfaces, only about $\frac{1}{16}$ of an inch is to be turned off on a side.

Whenever finish-turning the exterior of the gun can be combined with a boring operation, it is done. This is permissible in boring with the roughing reamer. A part of the exterior of the gun, from the *A*-hoop to the muzzle, is turned simultaneously with boring. But, as the diameter of the exterior is much larger than that of the bore, and a cutting speed of about 6 feet per minute is to be maintained in turning, the boring speed is reduced to 2 or 3 feet per minute; the boring-feed remains unchanged. The progress in boring is thus considerably reduced; but it is, nevertheless, economical to combine the two operations.

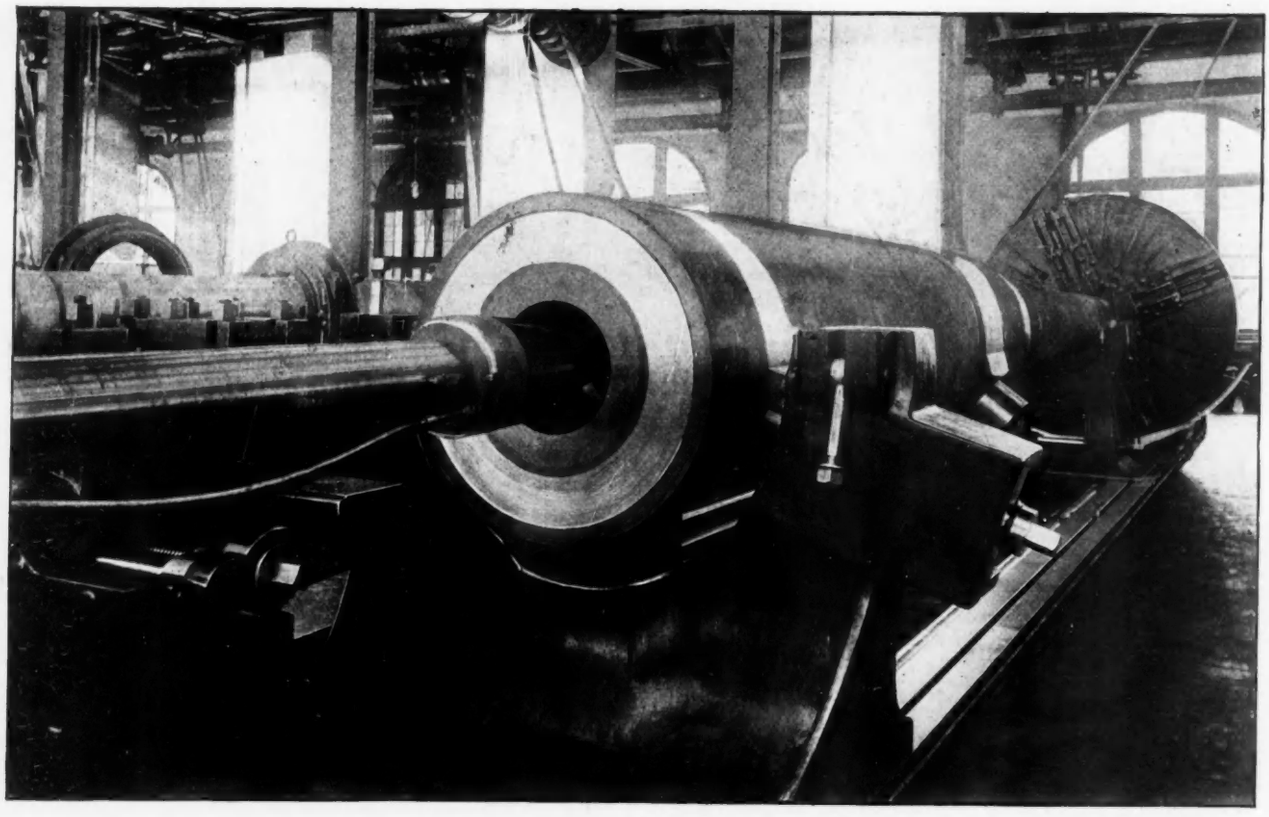


Fig. 12. REAMING CONICAL SLOPE BETWEEN POWDER CHAMBER AND MAIN BORE, 12-INCH GUN.

The finish-boring operations consist in finish-boring the main bore, in rough-boring and finish-boring the powder chamber, in finishing the conical slope between the main bore and the powder-chamber bore, in preparing the gas-check seat, in preparing the bore for the breech-screw, and in boring the long forcing slope forward of the powder chamber. All these operations must be performed in the gun lathe.

In finish-boring the main bore, two wood reamers are used in succession. The first or roughing reamer is primarily

*This is an invention of Mr. Victorin's, on which he has applied for a patent.—Ed.

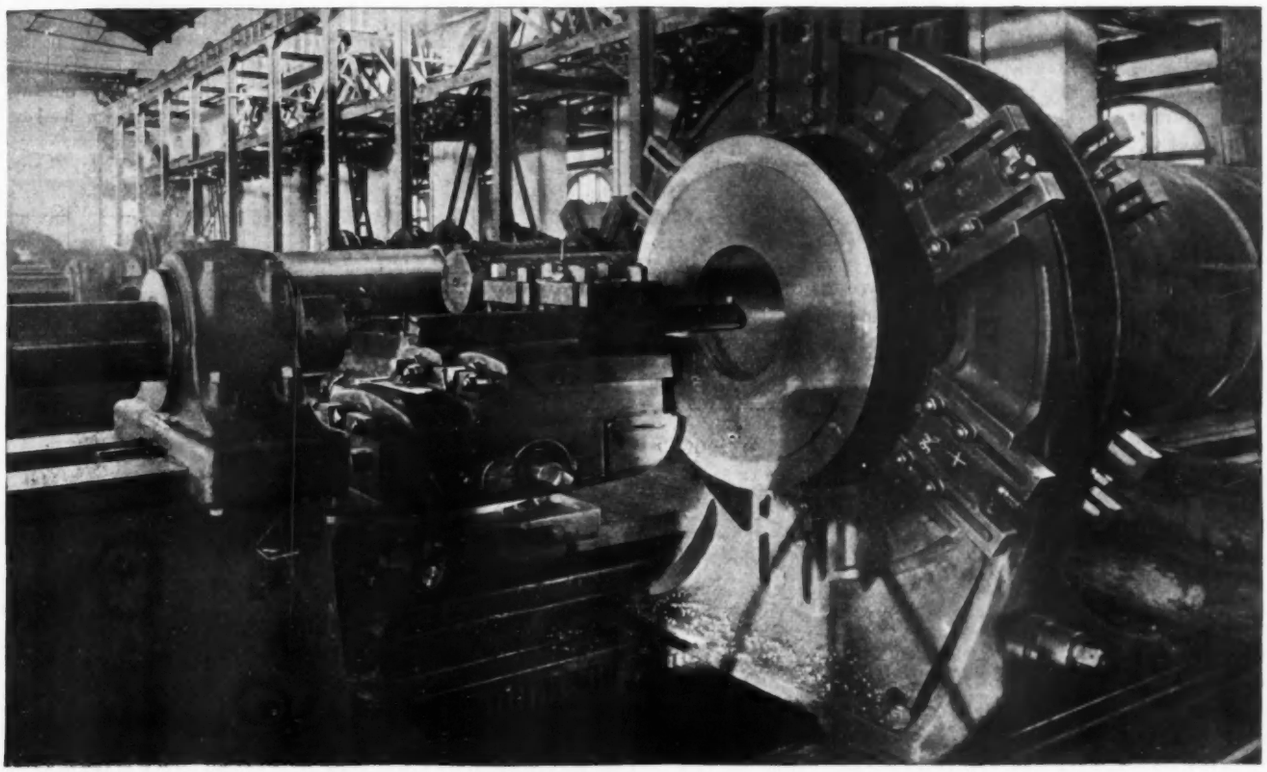


Fig. 13. SPOTTING BORE AT BREECH END OF 12-INCH GUN

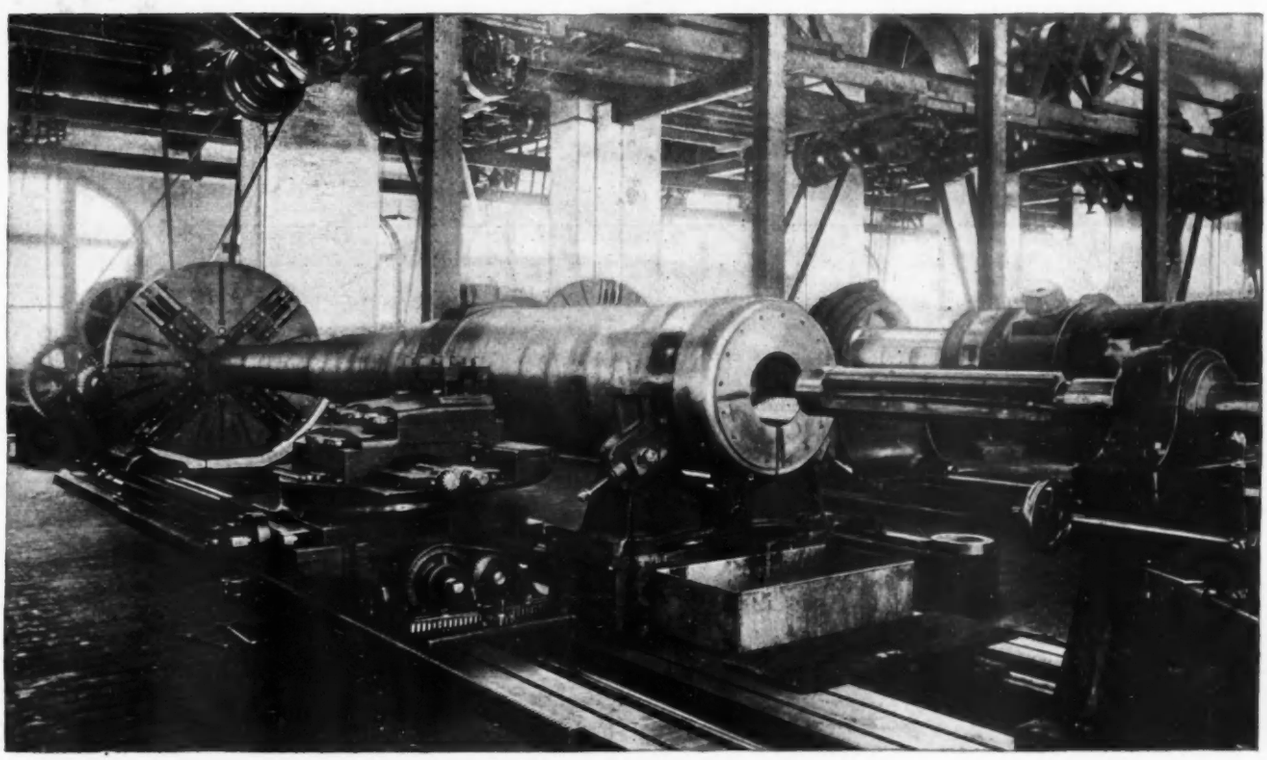


Fig. 14. REAMER FOR BORING FORCING SLOPE.

intended to straighten the bore, which may have lost its alignment in assembling the gun. This reamer enlarges the diameter of the bore from 11.6 inches to 11.9 inches. The final finishing reamer increases the bore to 12 inches.

With both reamers a cutting speed of 6 feet per minute is used, and a feed of about 0.07 of an inch per revolution.

The main bore being finished, the powder chamber is bored next. Up to this moment the bore has a diameter of 12 inches throughout. The powder chamber is an enlargement of the rear end of the bore. It is about 6 feet long and 14.2 inches in diameter when finished. 1.1 inch of stock must be removed on a side, which work represents the severest boring operations which the gun lathes for 12-inch guns are called upon to perform. In rough-boring the powder chamber, the bore is enlarged from 12 inches to 14.1 inches by means of a hog-nose tool similar to that employed in rough-boring the tube. The usual cutting speed of 6 feet per minute is used in this case, with a feed of 0.01 of an inch per revolution.

It was found, however, that more economical results can be obtained by dividing the cut, using two hog-nose tools in succession. The first tool enlarges the bore from 12.0 to 13.5 inches, and the second one from 13.5 to 14.1 inches. The same feed and speed are used with both tools—6 feet cutting speed and 0.03 of an inch feed.

The powder chamber is finish-bored by means of a wood reamer, 0.05 of an inch of metal being removed on a side. The cutting speed is 6 feet per minute, and the feed 0.07 of an inch per revolution.

The next operation consists in boring out a conical slope at the junction of the main bore and the powder-chamber bore. This conical slope is 18 inches long, and has a diameter of 14.2 and 12.0 inches, respectively. Formerly, the great amount of stock to be removed used to be bored out in steps, after which a conical reamer was employed to finish the slope. In the present practice a conical reamer is employed for rough-boring as well as for finish-boring. The roughing reamer removes the metal to within 0.05 of an inch of the finished size all around. On account of the triangular section which is to be bored out, a hand-feed gives the best results. This feed averages 0.025 of an inch per revolution, at the usual cutting speed of 6 feet per minute.

Hand-feed is also employed in finishing the conical bore (removing 0.05 of an inch on a side). This feed is 0.2 of an inch per revolution, at the normal cutting speed of 6 feet. The reamer which is employed for this work is alike for rough and finish boring. It consists of a cast-iron body of the shape of the conical bore, with four taper recesses on its exterior. Four cutter blades, each of the full length of the head, are keyed in these recesses. These cutters are ground to the exact taper in a universal grinding machine, and each blade is grooved on its face. These grooves are about 0.01 of an inch in depth and about 0.5 inch wide. They form a helix or spiral. The rear, larger, end of this reamer fits the powder chamber and insures concentricity of the two bores.

In finish-boring the powder chamber, a wood reamer is employed (Fig. 11, p. 21) which enlarges the hog-nose bore of 14.1 inches to 14.2 inches, at the usual cutting speed of 6 feet per minute and a feed of about 0.05 of an inch per revolution.

The conical slope between powder chamber and main bore is finished by means of a conical reamer (Fig. 12, p. 22) having a cast-iron body and four long cutter blades. A very fine hand-feed is employed for this work, because the work of this reamer begins in removing the steps formed in roughing out the slope, and takes finally a cut extending over the entire length of the cutters. A wood reamer with special cutters is employed for finishing the gas-check seat.

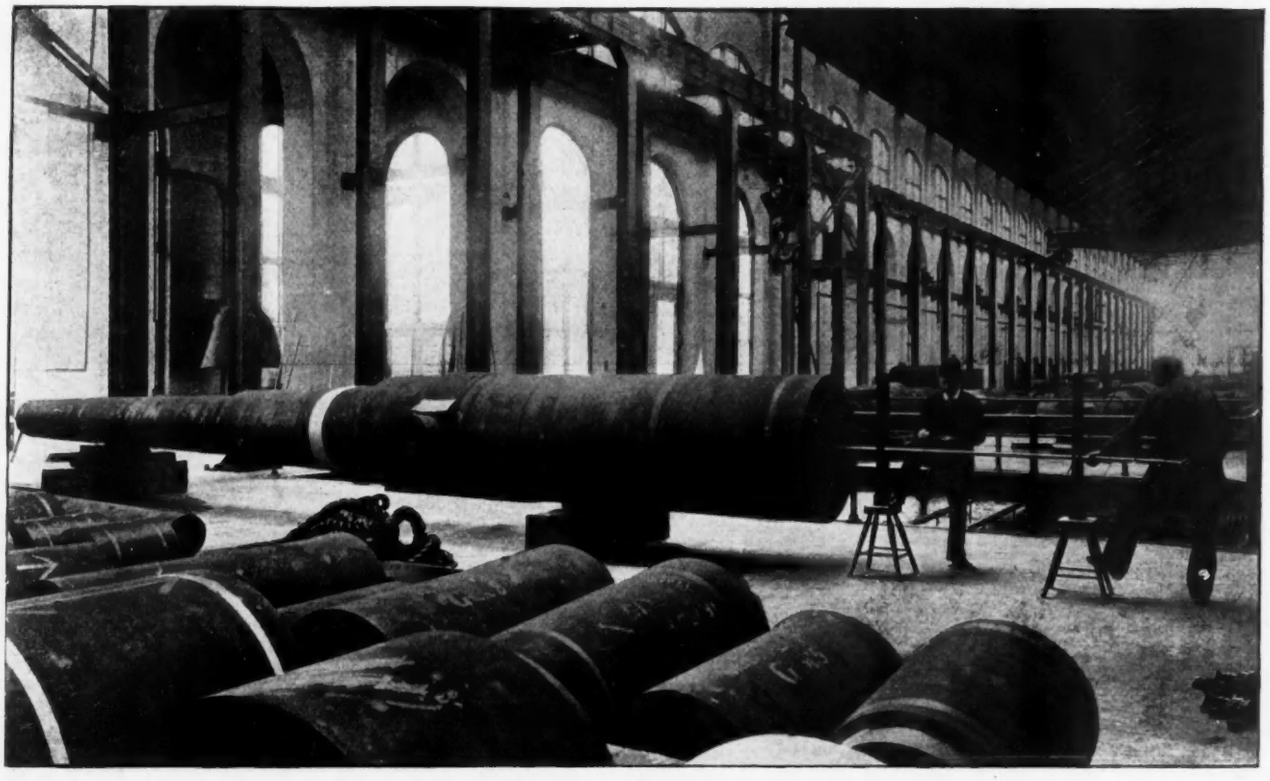


Fig. 15. STAR-GAGING ASSEMBLED GUN TO MEASURE COMPRESSION OF BORE

The screw chamber is prepared by boring out an annular recess immediately behind the rear end of the tube. This is done by the tool carriage by means of an overhanging tool (Fig. 13).

The final boring operation consists in boring the forcing slope. This is a slender taper bore of considerable length at the rear end of the main bore. Its total taper is 0.03 of an inch on a side. This operation is not performed until after the gun is rifled. The tool employed for this purpose (Fig. 14) consists of a long, slender cast-iron body with three cutter blades, each extending over the entire length of the cutter head. Hand-feed is used in this operation also.

The forcing-slope is 48 inches long. Hand-feed is employed in boring this slope. This feed is 0.20 of an inch per revolution, the cutting speed 6 feet per minute.

Inasmuch as the forcing slope and the conical slope must be concentric with the main bore, the cutter heads employed for these purposes are provided with bronze guide rings at the forward end, which are supported in the main bore.

The remainder of the principal operations required for the completion of the gun consist mainly in rifling the bore of the gun and in threading the breech. This work is not performed in the gun lathes at the Army Gun Factory, as special machines are provided by the Ordnance Department for this purpose.

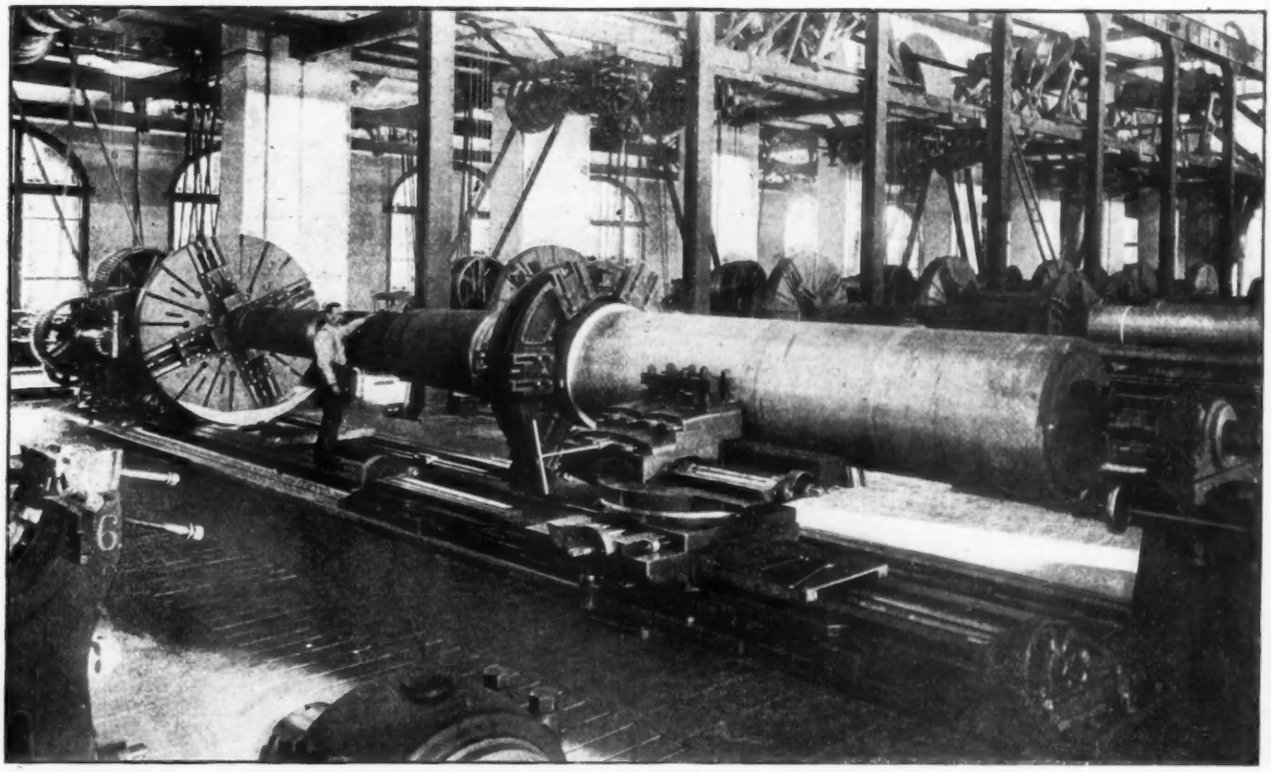


Fig. 16. TURNING SHRINKAGE SURFACE ON BREECH OF 12-INCH GUN FOR ASSEMBLING EXTERIOR LAYER.

Make It Easy for the Customer.

A German writer to an English paper calls attention to a rather anomalous practice. He says:

"We sell to England, and also buy by correspondence. We have always to quote in English weight and measure and deliver in English ports, no matter if it is difficult for us or no; but if we get an offer, say, from Birmingham, it comes in English weight, and many with 40, 10 and 5 per cent. discount. It takes us half a day to make the calculation, considering freight and duty too, to find whether an article is cheaper in England or here. Even a plain article, such as japan, for instance, quoted in English gallons and English money, is difficult. We have to reduce the gallons to litres, find the weight of a litre (for the article is sold here by weight), and then figure out the English money after the exchange rate. Such a simple calculation takes an hour at least; and as long as your fellow-countrymen do not quote money and currency of the land the goods go to, they will lose half of their trade. Time is money with other people too (not alone in England), and this should always be well considered by your people."

▲ ▲ ▲

Towards Respectable Pay.

The Revenue Marine Service of the United States, as is well known, is under the Treasury Department of the Government, instead of under the Navy Department, where one would naturally look for it.

The present Chief Engineer of the service, John W. Collins, has duties corresponding to those of the Chief Engineer of the Navy. He attends to such matters as the preparation of specifications for engines and machinery for new revenue cutters, the general supervision and inspection of all materials entering into the construction of both hulls and machinery; has charge of the installation and management of the electrical apparatus, and the supervision of the repairs and maintenance of the thirty-six cutters now in the service.

He receives the munificent salary of $1,800 per year! and an effort is being made to increase it to $2,500. It is to be hoped that the Government will be able to afford it.

The Engineer-in-Chief of the Navy receives $5,000 per year, with the rank of Commodore.

In this connection it may be interesting to note some of the salaries now received in England for similar service, as given below.

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Salaries of English Naval Constructors.

The Admiralty have sanctioned the following improved scale of salaries per annum to the engineering and constructive staff at the London establishment and at the dockyards, and these increased rates of salary will come into force on April 1st.

At the Admirality—Director of Naval Construction's Staff: The Senior Chief Constructor, £1,000 to £1,150; two Chief Constructors, £850 to £1,000. Director of Dockyards' Staff: Chief Constructor, £1,000 to £1,150; Engineer Assistant, £800 to £950. Engineer-in-Chief's Staff: Chief Engineer and Inspector of Machinery, £1,000 to £1,150; Engineer Inspector for Gun Mountings, £620 to £770.

At the Dockyards—The Chief Constructors at Portsmouth, Chatham and Devonport, £700 to £850; at Sheerness and Pembroke, £600 to £750; at Malta, £650 to £800; at Hong Kong, £600 to £750. The Chief Engineers at Portsmouth, Chatham and Devonport, £600 to £750; at Malta, £550 to £700; at Hong Kong, £500 to £650. These officers also have Government residences.—"The Engineer" (London).

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A Notable Publication.

Our readers are, we think, to be congratulated upon the possession of the articles presented in this issue, giving very full details of the largest engine lathes designed by the Ordnance Department, and an authoritative account of how the lathe work is to be done with such tools. The engravings alone tell a graphic and very interesting story, and, so far as we know, no such complete and detailed account of an equally important gun-making tool and of gun-making processes has ever before been published; and, in fact, would have been practically impossible for this journal to accomplish under the conditions of its management that existed up to a few months ago.

Unfortunately for us, no guns larger than 12-inch have yet been made at Watervliet, and Mr. Victorin has therefore been obliged to content himself with photographs showing operations on guns of that size; while the large engraving of the lathe, made from a photograph taken in the shops of its builders, shows a gun of only 10-inch caliber in the lathe. Perhaps the lathe itself is better shown thus; but it does not give an adequate idea of the work for which the tool was constructed. A very good idea of this is given by Mr. Victorin, however, on page 15, where he has drawings of a 10-inch, a 12-inch and a 16-inch gun, all made to the same scale.

Comparatively few men have much opportunity to become acquainted with work of the character referred to, and to those who have no such opportunities, as well as to those who are more directly interested in such work, this number should be exceptionally interesting.

Though the work of only one tool-building shop happens to be brought into prominence in these articles, yet practically all the shops building heavy tools, and some of those who build smaller ones, have contributed to Watervliet's equipment; and we hope we shall be able to give some further account of what is done there and how it is done.

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Our New Design.

The "American Machinist" has not contracted the "special number" habit, but is enlarged for this issue simply that it may treat a rather large subject adequately.

This number is, in fact, a practical illustration of one of the points referred to in the first issue for this year, when we set forth some of the reasons for re-designing the paper; among them being its thus acquired power of expansion to suit circumstances.

The three months during which the paper has been published in its new form have shown us that it meets very general approval among our readers, the dissenting voices being in a very small minority. Our own experience in using it as a volume of reference convinces us that its increased convenience is a decided improvement, and our correspondence shows that our readers very generally agree with us on this point; and certainly there has not been a previous time during the past nine years, if ever before, when so much interest was shown in what the paper is publishing, or when so much correspondence would be called out by a particularly interesting or suggestive article. There is, in fact, every evidence that the paper is more widely and more appreciatively read now than ever before.

As we expected would be the case, some readers who have followed the paper from its inception were shocked by its changed appearance, and at first did not like it; yet most, if not all, of such readers from whom we have heard now give the paper as hearty approval as ever before.

Our Electrical Department is an assured success, and the review we are giving each week of the commercial situation in machinery lines is highly appreciated. It is carefully and conscientiously conducted, and is unique—there being no other similar treatment of the commercial aspects of the machinery business, so far as we are aware.

Our contemporaries have our thanks for very kindly expressions of good-will in connection with changes of form and of management, and we appreciate the kindness in this respect of "Dixie," "The Foundry," "Age of Steel," "Machinery," "The Engineering Record," "The Coal Trade Journal," "The Iron Trade Review," "Sewing Machine Times," "Waltham Free Press," "Boston Journal of Commerce," "Engineering," "Engineer," and "The Mechanical World."

The last-named is the only journal which seems to doubt the wisdom of all of the changes made. It thinks the establishment of an Electrical Department may have been a mistake, in view of the fact that the field of electrical journalism seems to be pretty well filled. In its same issue our contemporary republishes in full an article from that department, which it would probably have looked for in vain among electrical journals, thus showing its practical appreciation of the fact that we are treating electrical matters from the standpoint of the machine constructor, and differently from its treatment in electrical journals.

Altogether, we have reason to be well satisfied with the result of our new design, and we have abundant evidence that our readers are also well satisfied with it.

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Power for Reversing Planers.

In conversation with Mr. Bancroft, of Wm. Sellers & Co., recently, the subject of the heavy absorption of power by planers at the moment of reversing came up. Mr. Bancroft stated, as a matter of knowledge, that the greater part of this power was absorbed by the belt pulleys and attached parts, and not, as would naturally be supposed, by the planer table—the great velocity of the pulleys more than making up for their light weight. To the discovery of this surprising fact is due the development of the Sellers quick-return planer.

A striking corroboration of it will be found in our report of tests of power required by machine tools at the Baldwin Locomotive Works. Among the tests were those of two Sellers planers, of precisely the same size and doing the same work—but one of them of the old construction, and the other of the new or quick-action pattern. In the older pattern the belts are shifted and the pulleys reversed in the usual way; while with the new pattern there is no reversal of the pulleys, which run on continuously.

In addition to this, the two machines were driven by the same motor when the tests were made—this motor being taken from tool to tool in order to determine the proper sizes of motor to be permanently connected to the various tools. The conditions were thus absolutely identical, except for the reversal or non-reversal of the pulleys. If our readers will refer to our issue of February 6th, they will find that the power required by the new pattern machine at the moment of reversal was 17 horse-power, while the

horse-power absorbed by the cut was 20.6 to 21.6—the power at the moment of reversal being less than that absorbed during the cut. With the old or shifting-belt planer the facts are very different. Here the horse-power during the cut was 23 to 26—not very different from the first machine; but at the moment of reversal it rose to 47 to 50—say twice the power absorbed by the cut.

Additional emphasis is given by the fact that the new pattern machine had a higher speed of return to the table than the older one; and yet the power absorbed in getting the new table in motion is but 34 to 36 per cent. of that absorbed by the old one.

There seems to be no escape from the conclusion that the surplus of power required to reverse the old planer went into the belt pulleys—a fact which we think most mechanics would require absolute proof before accepting.

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Standard Centers.

It will be remembered that we some time ago attacked the superstition which makes machinists believe, that while for light work standard 60-degree centers may be all right, for heavier work centers must be more blunt—say 75 degrees or 90 degrees. We believe this is nonsense, and that 60-degree centers are equally well adapted for the heaviest work.

Our friends who are doing what they call heavy work, such as locomotive driving axles and wheels, for instance, and who think 60-degree centers are more delicate affairs than blunter ones, and will not do for such heavy work, may appropriately contemplate the fact that the centers for the lathe illustrated in this number are standard 60 degrees, and that the work designed to be done upon it weighs about as much as four ordinary locomotives complete, including all the driving axles and wheels under them.

We think the Navy should, for the sake of facility in repairs, require that all machine work done for the Navy should be done upon standard 60-degree centers.

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The space required for the two leading articles in this issue compels us to omit our Electrical Department this week, and to put up with much less variety of subjects than we are usually able to present.

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Literary Notes.

The first number of "Compressed Air, devoted to the useful application of compressed air," appears in attractive form and very near the standard size, 6x9. Many interests far less important than this of compressed air have now their representative journals. W. L. Saunders, C. E., the editor and proprietor of the present publication, is exceptionally favored for the collection of the latest developments and data upon this important topic, and the first number contains an attractive array of matter. The illustration of the most popular belt compressor in the world, and another cut showing a strikingly novel and original application of compressed air, cannot fail to make a hit. Published at 26 Cortlandt street, New York. $1 per year.

We have received Volume XVI of the new series of "The Locomotive," published by the Hartford Steam Boiler Inspection & Insurance Company. It contains interesting matter relating to boiler construction and management, and the fullest available record of boiler explosions for the past year. The number of explosions recorded is 354, with 378 deaths. The subscription price is $1 per year.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(73) H. L. E., Louisville, O., asks: What kind of packing should I use on a pump for hot water, that is on the plunger? A.—Any kind of packing, fibrous or flexible, that is suitable for steam piston-rod stuffing boxes should do for hot water pump plungers. If a fibrous packing, such as flax, is used, do not oil the packing before putting it in. The oil prevents its soaking up and filling with water, and makes air leaks possible.

(74) F. M., Waterbury, Conn., writes: I would like your opinion in regard to hardening taps and dies—made of the best of Jessop's tool steel, heated in a charcoal fire, and dipped in sulphuric acid to cool. Do you think sulphuric acid has anything more to do in stopping the expansion and contraction of the taps than clear water would have? A.—It may be that sulphuric acid for quenching permits the hardening heat to be somewhat lower than would be necessary with water, and thus indirectly lessens distortion. We do not believe the acid can affect the steel to any important degree in any other way.

(75) "A Reader" asks: How is the angle of saddle of Brown & Sharpe milling machine computed? An example is given from the Brown & Sharpe treatise on the "Construction and Use of Milling Machines": diameter of cutter 4 inches, pitch to be cut 41.14, angle of saddle 17 degrees. And our correspondent adds: The circumference of cutter divided by the pitch gives the tangent of the angle. Now, how are the degrees computed from the tangent? A.—The degrees are ascertained from a table of tangents. To understand how the table of tangents is constructed, a treatise on Trigonometry should be studied.

(76) A. L. B., Harvey, Ill., asks: Supposing a car weighing 20,000 pounds and its load weighing 40,000 pounds, all on a good level track of steel rails. The car has four wheels, the axles running on hardened steel roller bearings, each wheel being independent. How much dead pull will it take to start from rest and attain a speed of 150 feet per minute in, say, 20 feet? How much dead pull to maintain a speed of 150 feet per minute? A.—A very clear and satisfactory mode of treating this and similar questions has appeared in our columns since the above query was written by our correspondent. See "Power Calculation for a Traveling Crane," in the "American Machinist," April 2d, page 9.

(77) W. P. D., Newport, Ky., asks: Can you give me a formula for calculating the force of water when confined and heated from 32 degrees to 212 degrees? Or, in other words, suppose I have a cubic foot of water in a closed vessel at 32 degrees, and heat to 212 degrees, what will be the pressure? A.—This is a question that it is impossible to answer. Theoretically, the pressure would be equal to that required to mechanically compress it from the larger volume to the smaller, and this has never been done. A pressure of 2,500 pounds per square inch, it is said, will so increase the density of water that a cubic foot of it will weigh half-a-pound more than without the pressure; but the difference in weight between a cubic foot of water at 32 degrees and at 212 degrees is more than 2½ pounds.

(78) W. T. McL., Concord, N. H., writes: In the "American Machinist," February 27th, page 16, something is said relative to a standard catalog of dimensions. What is the usual custom in giving dimensions? Should the length be given first, or the diameter? For instance, in ordering bolts, would you say 4 x ¾ inch, meaning 4 inches long by ¾ inch diameter; or should the diameter be given first? This question is meant to apply to all kinds of material as well as bolts. A.—Our correspondent curiously misunderstands or misuses the matter referred to in our columns. We referred not at all to catalogs of standard dimensions, but to a standard of dimensions for catalogs, so that manufacturers and others who issue catalogs should make them all of the same size, and every one would find it more convenient to use and preserve them. As to the actual question asked, we would put the diameter of the bolt first and the length last, and in general we would put first that particular which most fully indicated the size; or, if making a list, we would put first that particular which would stand the longest without change. Thus, under diameter of bolt we might range a great many different lengths, while under any single length of bolt we would not put very many different diameters. The custom in regard to this matter is not very rigid.

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Business Specials.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Adding Machine. Grant: see page 33.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Honest Mach. Oils. F. S. Pease Oil Co., Buffalo, N. Y.

Engine Castings ⅛ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Mannocitin permanently prevents rust. Testimonials explain. O. Goetze, 14 Whitehall st., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill, 913 Tilden street, Saginaw, Mich.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

Stuffing Boxes.

BY F. F. HEMENWAY.

Your correspondent, J. H. Dunbar, in issue of March 19th, brings up the always interesting question of the depth of stuffing boxes, and in a way that is suggestive.

While stuffing boxes are used for a single purpose, the conditions of use are so various as to require a good deal of judgment in the way of proportions, and this is particularly true in relation to their depth. A deep stuffing box may be undesirable where the travel of the stem it is to pack is only short and at unfrequent intervals, but it is of great importance when the reciprocations are 300 to 500 times per minute.

For example, Mr. Dunbar cites the hydraulic crane in which the packing is very shallow, and says it has answered as well or better than deeper packing. I am bound to believe that it has answered very well, but must exercise my inherent right of prejudice that leads me to believe that two or three years' use will show its weakness as compared with deeper packing. Perhaps I am all wrong. There is, as compared with steam engine work, but little motion, and the packing may answer very well indeed; but I doubt its being so good, in all considerations of the case, as a packing three times the depth would have been.

Referring to Mr. Dunbar's rather evident indorsement of an Unwin stuffing box, in depth the diameter of the rod, I shall never be, I fear, enticed into believing this, notwithstanding the eminent authority. In these days of balance valves the valve stem is frequently no more than ⅝-inch diameter; but with a rod reciprocating 300 to 500 times per minute, I do not believe Mr. Dunbar would be willing to trust a stuffing box for fibrous packing only ⅝ of an inch deep. I know I should not.

Mr. Dunbar's experience to the effect that a shallow stuffing box causes less friction and less wear on the rod than a deep one, is exactly contrary to mine if it is desirable, as it generally is, to entirely prevent leakage. I have found that with any kind of fibrous packing the result is increased friction and inevitable scoring of the rod. This always was, as it seemed to me, a natural sequence.

I remember an instance which forced the matter of shallow stuffing boxes upon me rather plainly. At just about the same time two men—different concerns—built each an engine that were to go in near together. We may call one of the men W. and the other H.

There was this point of similarity between the engines: The cut-off in both cases was through releasing mechanism, and the valves, two in each case, were closed by an unbalanced pressure acting on an area represented by the cross-section of vertical valve stems. The valves of one of these engines would close as easily as those of the other.

But there was this difference: The stuffing boxes of the W. engine were very shallow and those of the H. engine unusually deep. In the instance of both engines, Tuck packing was used. The area of cross-section of the W. engine stems was .6 inch, and of the H. engine .3 inch. There was as much force exerted to close the W. valves as there was to close the H. valves.

If the shallow packing on the W. engine was screwed up tightly enough to prevent vigorous leaking the pressure acting against the .6-inch area would not close the valves. There was nothing but a leak that was a waste of steam and a nuisance, and new packing would be required every two weeks; once a week the engineer said.

The deep packing lasted, to my knowledge, for a year and was always tight. How much longer it lasted I don't know. The .3-inch area was always sufficient for closing the valves very promptly. It required three times as much packing to pack the deep box as it did the shallow one, but a half dozen times as much to keep the shallow one packed for a year as it did the deep one. The first cost of packing, which Mr. Dunbar refers to, does not enter into a consideration of the case.

I have never known an instance anywhere about a steam engine in which a shallow stuffing box was not an unprofitable investment. Shortening up a stuffing box, in order to get an engine an inch or two shorter, is generally a costly saving. It saves a little once and loses always.

I do not make the attempt to set myself up as any sort of an authority on the depth of stuffing boxes. Candor compels me to admit, that I did once attempt to conjure up a formula for my own use, but equal candor compels me to admit that I was utterly routed in the attempt. I could make a formula that would answer through a small range of sizes, then another formula for another range. Got so many of them that I needed a chart and compass to assure me that I was using the right one.

The upshot was a memorandum that I find in an old book now before me. It refers to rods for steam engines not less than ⅝ inch diameter, and reads as follows:

"Never make the depth of stuffing box for any known fibrous packing less than 1¾ inches deep. When a size of 1-inch rod is reached the depth should not be less than 2 inches. For a size intermediate the depth may be 1⅞ inches. For a rod 1½ inches diameter, the depth may be 2½ inches, and for a 2-inch rod it should be not less than 2¾ inches deep; for a 3-inch rod it should be 4½ inches. For a 5-inch rod a depth of 6 inches should be allowed, and for a 6-inch rod a depth of 8 inches."

While I have had occasion to deal, to some extent, with hydraulic packing up to 12 inches diameter, my experience has been so slight as to lead me to say nothing on this subject. If actual experience in relation to packing is to have expression, as it certainly should, I may ask the indulgence of space to say something further. At the present, all I can say is, make the stuffing boxes a little deeper.

Although reference has been to those of fibrous packing only, it is, in my opinion, equally applicable to metallic packing.

I am interested in the opening of the subject by Mr. Dunbar, and, accompained by your request for further discussion, I have no doubt that the bright readers of the "American Machinist" will give us old fogies more light.

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Commercial Review.

NEW YORK, SATURDAY EVENING, APRIL 4TH.

Engines, Boilers and Pumps.

The advent of spring has failed to introduce much poetry into the engine market. To be sure from many parties there are reports of improvement, and perhaps their number is as large as that of the despondent ones. But taking the situation all in all, it does not appear to be materially different from its case a month ago.

In boilers, one prominent company has been doing a good business of late, but thinks that the outlook is not so good as it was a month ago because it receives less inquiries than at that time. Another concern, which is of high prestige, has found the trade of the last two months, especially, very good, which is apparently above the average of the market. Its selling has been notably in connection with office buildings, street railways and Government work.

In connection of office buildings, it may be said that the number of building permits issued in this city during March was much in excess of the number for the corresponding month a year ago, which means a demand for both engines and boilers.

The Harrisburg Foundry and Machine Works, manufacturers of the Ide engine, etc., write us that their business for March, 1896, as compared with the same month last year, has been greater, but they cannot say that prices have improved any. "The increased volume, however, is no indication of improved conditions, inasmuch as work in hand is largely special direct-connected work for lighting and railway purposes for which our engine appears to be especially adapted and accepted with favor. We have to-day on our order book orders for forty engines of various sizes for future delivery, ranging from 30 to 500 horse-power. The situation cannot be said to be hopeful until better prices prevail. The New York representative of the foregoing company,

who has been doing a very good business of late, tells us that, in addition to engines to be used in electric lighting his trade comprises notably those designed for running shops by electrical transmission of power. In this class of work, it is common to employ three, or perhaps five engines of moderate size instead of one larger one, it being believed that when but a part of the shop is in operation a greater economy is thus attained.

An engine and boiler concern of this State, which makes a specialty of Corliss engines, writes as follows: "The year 1896 commenced with a marked improvement in our business over last year, which, however, has not been as well maintained as we hoped. Still the volume of business is larger than a year ago, but the tendency seems to be toward lower prices."

Engines of the Corliss type would appear to be somewhat dull, as a rule, though it is unsafe to assert that they are more so than those of other classes. The Allis Company is reported as having on hand work for some seven months ahead, but composed largely of old orders.

The New York representative of one of the larger steam pump companies defines the situation in that line as being a waiting one on the part of buyers, notwithstanding there is just as much business as ever in sight. Marine pumps are still one of the features of the market, and those for use by street railway companies are also mentioned. Some concerns have done a pretty fair business in March.

Iron and Other Metals.

As stated last week, Southern irons have been comparatively active at the low prices for which they have been obtainable. A pool has now been formed by some Southern furnace men by means of which the minimum has been raised 25 cents a ton. There is more doing in Northern irons than there was a short time since.

The daily press has given full accounts of a pool just formed by the Bessemer billet manufacturers, with an agreement to fix the price at $20.25 per ton in the Western market, and in the Eastern, $22.75, an advance of $3.25 above the quotation prevailing in the East recently. Tin bars are to be advanced to $22 and sheet bars to $23, Western rates. The combine comprises a strong personnel.

Copper is stronger in tone, influenced by heavy exports and European consumption, and a good statistical position.

Pig tin has been quiet in the domestic market, although there has been some speculative activity in that of London.

Lead has weakened in price, until now purchases could easily be made at 3.05 and it is even reported to lack firmness at 3.00c.

Spelter has been quiet in this market.

Quotations.

NEW YORK, Saturday Evening, April 4th.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 50 @ $13 25
No. 2 foundry, Northern	12 00 @ 12 50
No. 2 plain, Northern	$11 00 @ $11 50
Gray Forge	11 25 @ 11 75
No. 1 foundry, Southern	11 75 @ 12 00
No. 2 foundry, Southern	11 25 @ 11 50
No. 3 Southern	10 75 @ 11 00
No. 1 soft, Southern	11 50 @ 11 75
No. 2 soft, Southern	11 00 @ 11 25
Foundry forge, Southern	10 25 @ 10 50

Bar Iron—Base, in Carloads—Mill price, on dock: common, 1.17½ @ 1.25c.; refined, 1.25 @ 1.45c. Store prices, f. o. b.: common, 1.40 @ 1.55c.; refined, 1.50 @ 1.70c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c.; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—From store, about 1.75c. Special brands upward.

Cold Rolled Steel Shafting—Base, 2½c. in carloads; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 10¾ @ 11c.; electrolytic, 10⅝ @ 10¾c.; casting copper, 10¼ @ 10½c.

Pig Tin—For 5 and 10-ton lots, 13.50c. f.o.b.

Pig Lead—In carloads, about 3 00 @ 3.05c., f.o.b.

Spelter—In carload lots, New York delivery, 4.15 @ 4.20c., for fairly good brands.

Antimony—Cookson's, 7¾ @ 8c., according to quantity; Hallett's, 6¾ @ 7c.; Japanese, 6¾ @ 6 85c.

Lard Oil—Prime city, 50 @ 51c., in carload lots.

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Manufactures.

The Darling Pump & Mfg. Co., of Williamsport, Pa., are adding to their already extensive plant. This firm has been very busy for the last year.

The Bloomsburg Brass & Copper Co., Bloomsburg, Pa., have contracted for two new hydraulic drawing tables, which means the enlargement of their die-making department.

The Crescent File & Tool Co., of Wilkesbarre, Pa., which is now in the hands of a receiver, is endeavoring to reorganize, and should this be accomplished the present plant will be enlarged.

Ellwood Bros., silk manufacturers, of Fort Plain, N. Y., are intending to remove their business to Watertown, N. Y. The mill, it is expected, will employ about 150 hands at the commencement.

Mr. F. G. Stieren, of Pittsburg, Pa., has under consideration the building of a large plant for the manufacture of cutlery of every description. This plant will be located on Second avenue, Pittsburg, Pa.

The York Mfg. Co., of York, Pa., have moved into their new foundry, and expect to get into the machine shop some time about the middle of April. We understand they have some machinery to obtain yet.

A large plant is being built at Foxboro, Mass., by the Van Choat Electric Co., to manufacture all kinds of electrical machinery. The buildings will be ready for the reception of machine tools in about two months.

The General Beaver Nail Works, at Bellefonte, Pa., have been leased by Mr. Henry Harris, who will thoroughly improve them and start them up at an early date. Mr. Harris is the owner of large nail mills at Georgetown, Pa.

At Bloomsburg, Pa., the Magee Carpet Works have enlarged their plant, which will enable them to double their output of last year. They intend to use a portion of the new building for a machine shop to do their own repairs.

The Dickson Mfg. Co., of Scranton, Pa., are to add to their present plant a building to be used as the boiler department, which will be equipped with the latest improvements. They are also going to overhaul the blacksmith shop.

It is very probable that in a short time the Howard-Bullough Machine Co., Attleboro, Mass., will build a large addition to their machine works. Twenty-two acres of land have been purchased, adjoining the company's present plant.

At Bellefonte, Pa., a large tool works is to be commenced, known as the "Bellefonte Hammer & Tool Co." Those interested are J. P. Harris, T. A. Shoemaker, J. S. Montgomery, W. R. Jenkins, Howard Single, Harry Jenkins and E. L. Ovis.

At Geneva, N. Y., Mr. Alfred Catchpole is to erect a foundry having brass furnaces, a jobbing shop, etc. These new buildings, which are to be added to his present plant, are to be devoted to the manufacture of a heater of which he is the patentee.

Watertown, N. Y., is the place where Mr. Chas. H. Remington has chosen to build a large paper mill this coming summer. It will consist of a paper-making plant and a wood-pulp mill, and is expected to give work to about 150 hands. Mr. George Fairbanks has been engaged to do the surveying and make the plans for the new building, which will have the latest improvements.

The manufacturing plant originally erected for the Para Rubber Shoe Co., at South Framingham, Mass., and which was later owned and occupied by the Hickory Wheel Co., has been purchased by the Dennison Mfg. Co., who will occupy it as soon as they can get moved from West Roxbury. They will add a new building to the plant, and will employ 800 or more men.

Messrs. Cawley & Dwyer, of Lowell, Mass., are about to erect a first-class steam laundry. The machinery will be of the latest improved pattern, and there will be a 75 horse-power engine and a boiler 42 inches in diameter and 14 feet long. They will use electric light and be heated by steam. The building will be of wood, three stories high, and boiler room in L, one-story high of brick.

R. Hoe & Co., of New York City, manufacturers of printing presses, have placed an order with the Berlin Iron Bridge Co., of East Berlin, Conn., for an all-steel building for storage purposes. This building will be 40 feet wide and 60 feet long, 3 stories high and will be absoluteiy fire-proof. To avoid condensation of moisture, the roof and sides will be lined with the Berlin Co.'s patent anti-condensation fire-proof lining on the under side of the corrugated iron covering. The floors are concrete supported by corrugated iron arches resting on I beams. A traveling crane is attached to the trusses, having a capacity of 3 tons, and so arranged that it takes the material to be raised in the building from the lower floor, and raises it to any part of the building on any of the floors.

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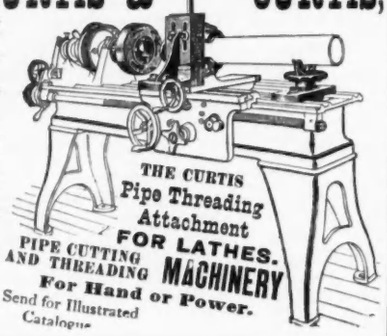

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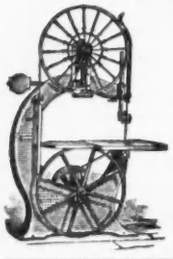

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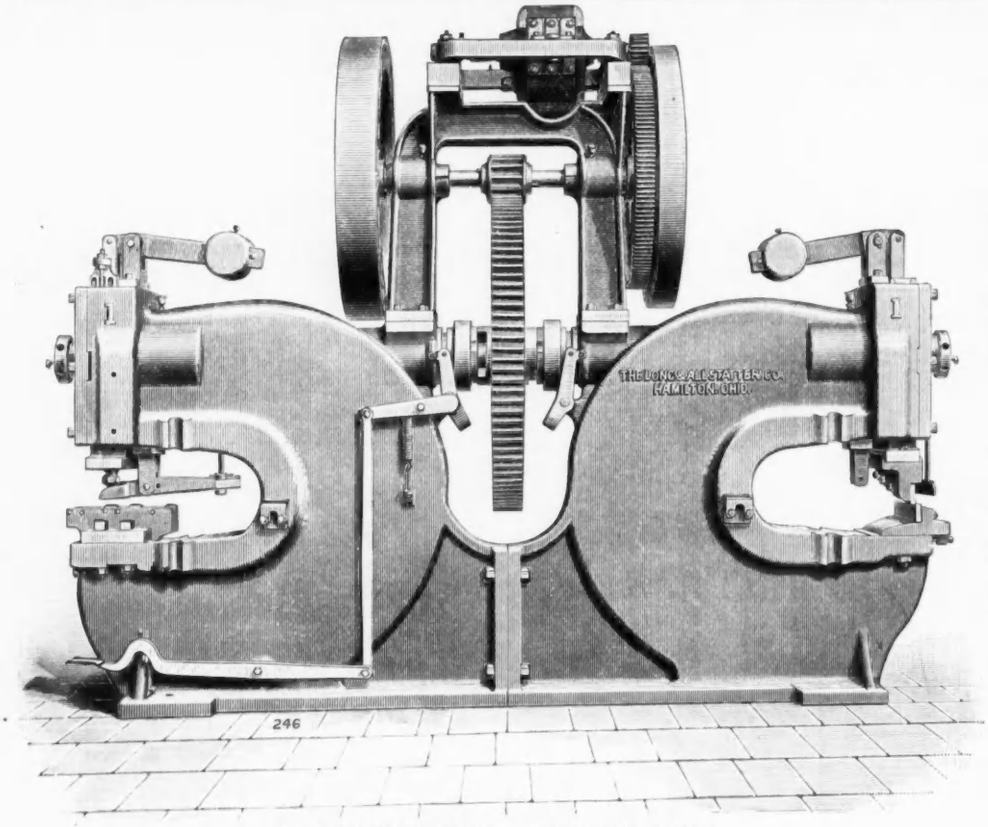

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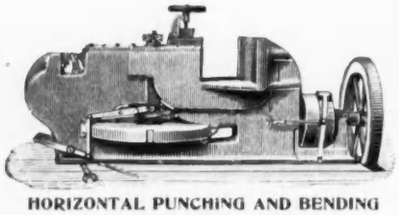

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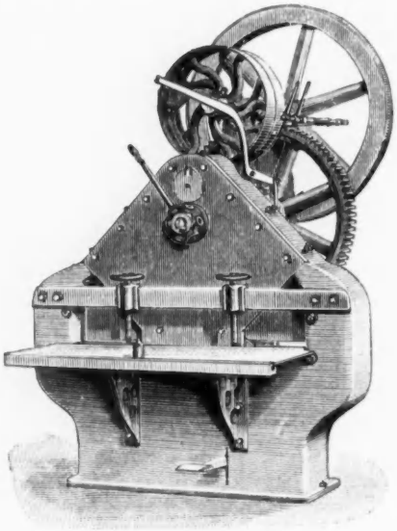

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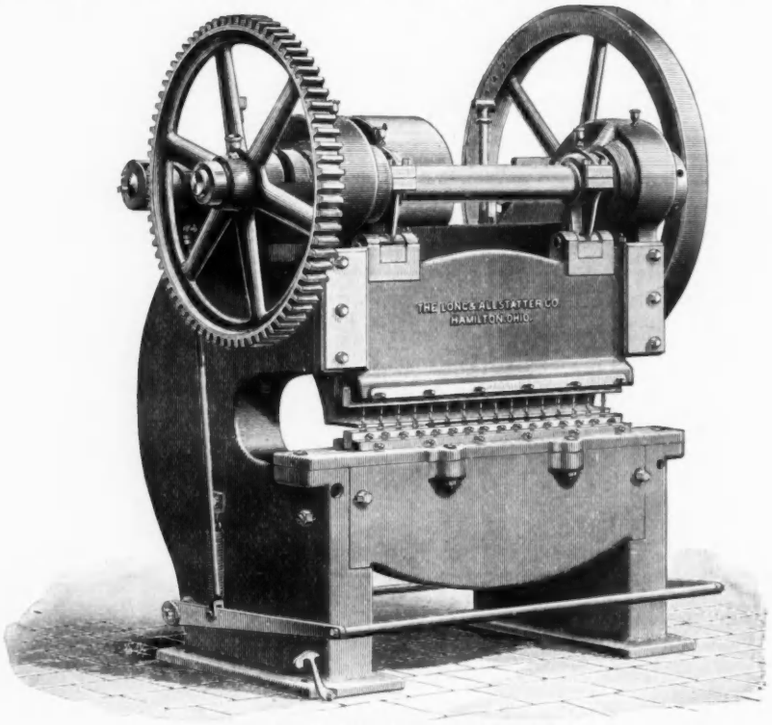

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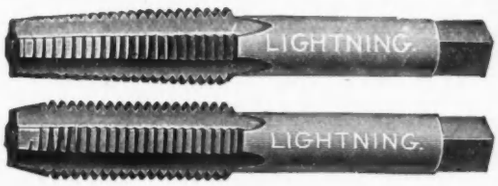

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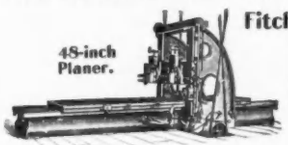

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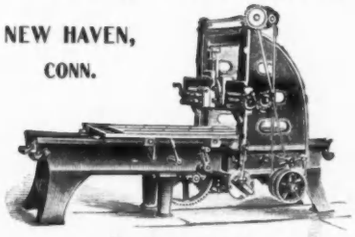

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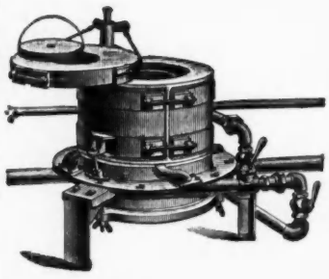

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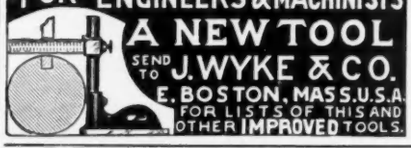
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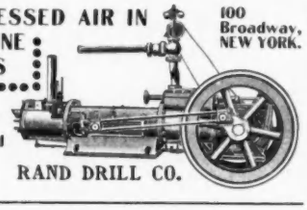
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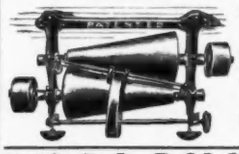
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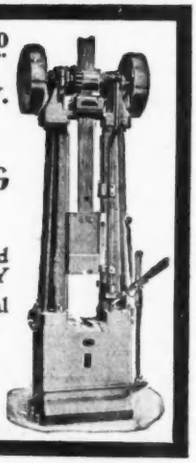

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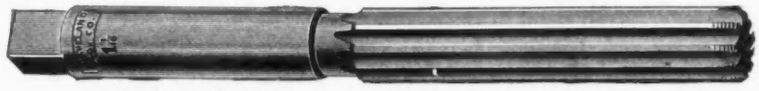

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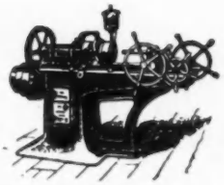

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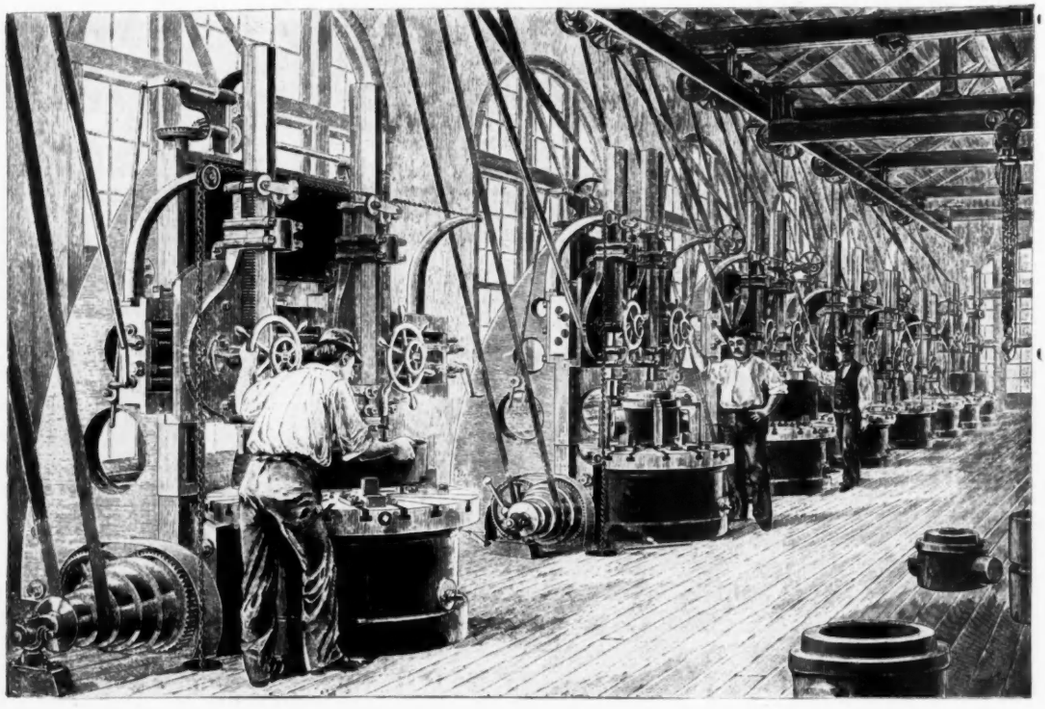
THE EQUIPMENT AT WATERVLIET ARSENAL.

A VISIT to Watervliet Arsenal is all that is necessary to convince one that the machinery equipment is complete and modern. It cannot but prove of intense interest to those that are keeping pace with the design of machinery of the most approved type and that displays the best of engineering skill. It will bear the closest study of every detail and it is very evident that the equipment has received the most careful attention of those that are best versed in machine design and construction, and displays a knowledge obtained from the most extended practical experience as well as the keenest perception of the elements that are essential for good machine design.

It is clearly evident that the "broadest gauge" has been displayed; there is no skimping of bearing surfaces, the face of gears is large, giving great strength and ample surface of contact; the texture of the metal is the best for heavy duty, maintaining accuracy of alignments and long service, and the metal is best distributed; in fact, we could readily enlarge upon the merits of these designs, but it would not convey in one small part the excellence displayed as much as would a personal visit to the Arsenal.

It must be a gratification to those that have watched the progress and development of heavy machine-tool building in this country to see that the builders can now take a position for skill and ingenuity second to none.

In walking through the Arsenal, we were particularly impressed with the most magnificent array of tools of one size and type that we have ever seen. There is one row of eight Niles Boring and Turning Mills used on gun rings, and their splendid proportions bursting upon the engineer's eye as he enters this department is likened to the wide expanse of magnificent mountains suddenly bursting forth before the eye of the naturalist.



NILES HOOP-BORING MILLS.

A reference to the cut above will give some idea of the general design of these machines, and we commend the study of every detail to the student of machine-tool design.

After this, however, there is still reserved a greater pleasure. It is the massive Gun Lathes for boring and turning 12-inch breech-loading rifles, built by the Niles Tool Works. These machines swing 96 inches over the

bed and are over 104 feet in length, there being two of the same size and length, each weighing over 150 tons.

We reproduce a photograph of one of these lathes below that will show great strength, power and most admirable proportions of these two machines.

Each of these machines consists of a nozzle and breech back-rests and boring bar with carriage in addition to the usual equipment. The tool carriage bed is composed of two sections some three feet wider than the remainder of the bed to carry the tool carriage on independent shears. The head-stock carries three spindles, consisting of the main, cone and back gear spindles.

Breech and muzzle rests and boring bar are provided.

In addition, the equipment of Watervliet Arsenal includes the following massive, heavy and magnificently proportioned machine tools:

Nine 48-inch Lathes for turning Jackets.

Three 60-inch Lathes for turning Jackets.

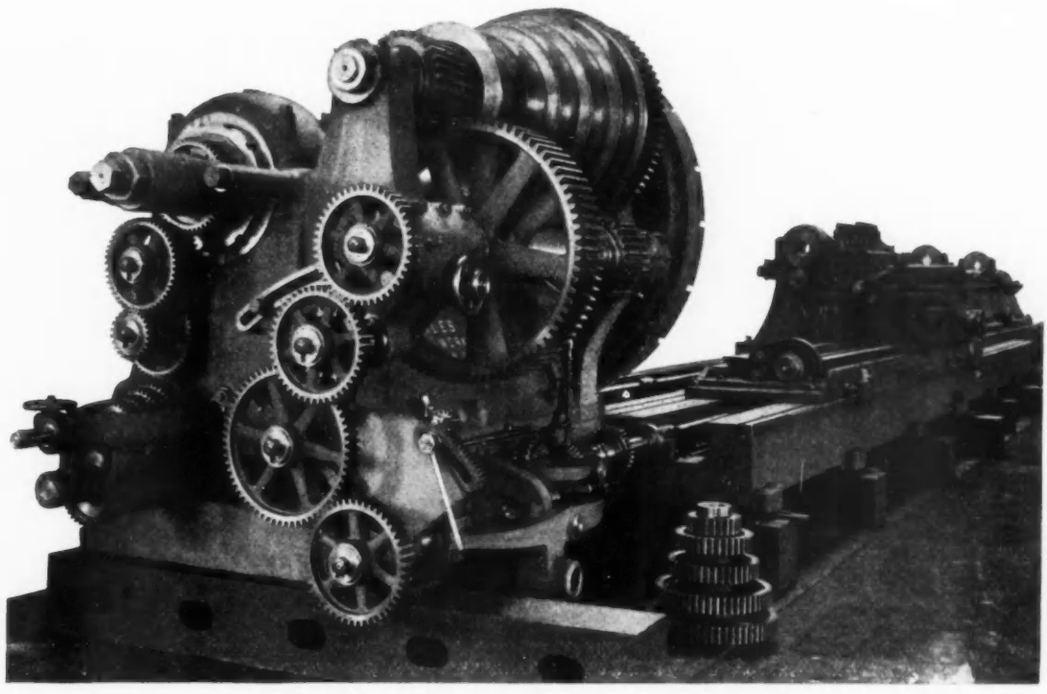
One 72-inch Lathe for turning Jackets.

Ten Boring and Turning Mills for Jackets.

Four Horizontal Boring Machines.

Two Horizontal Boring, Drilling and Milling Machines.

Five Planing Machines.



NILES 12-INCH BREECH-LOADING RIFLE LATHE.

The adjustable bearings are properly keyed to prevent rotation.

The gearing is such that twenty main spindle speeds ranging in geometrical proportion may be obtained, giving very wide range.

Means are provided so that the carriage may be shifted along the bed by hand.

The rear end of the slide is provided with a graduated segment whereby it may be set over to the proper point to give variations of taper diameters. Automatic feeds in two directions are provided for two longitudinal and two lower cross slides.

Three Slotting Machines and other smaller tools.

All of these were furnished by The Niles Tool Works Co., Hamilton, Ohio. Branches located at 136 Liberty Street, New York; Western Union Building, Chicago; 418 Walnut Street, Philadelphia; Lewis Block, Pittsburg; Room 44 Bell Telephone Building, Boston. They are prepared to give photographs and full data in regard to the details and construction of these machines, and we strongly recommend that those interested in getting further information in regard to this equipment correspond with The Niles Tool Works people.

The U. S. Army would cut a sorry figure if they went to war with the old cast-iron cannons that loaded from the muzzle and split at the breech. The modern, built-up, steel rifle is the development of a species—the survival of the fittest. It's not surprising that Uncle Sam keeps his old guns for what they have done, but if he built or bought more smooth-bores, we'd all vote him an old fogy.

The old, muzzle-loading, flint-lock typewriter with slam-up action and upside down writing is as far behind as the old smooth-bore gun. The modern typewriter (The Williams), has no ribbon, writes the whole line in sight, writes on top, has ball bearings, is compact, convenient and efficient, and, like the great rifle, hits the bull's-eye.

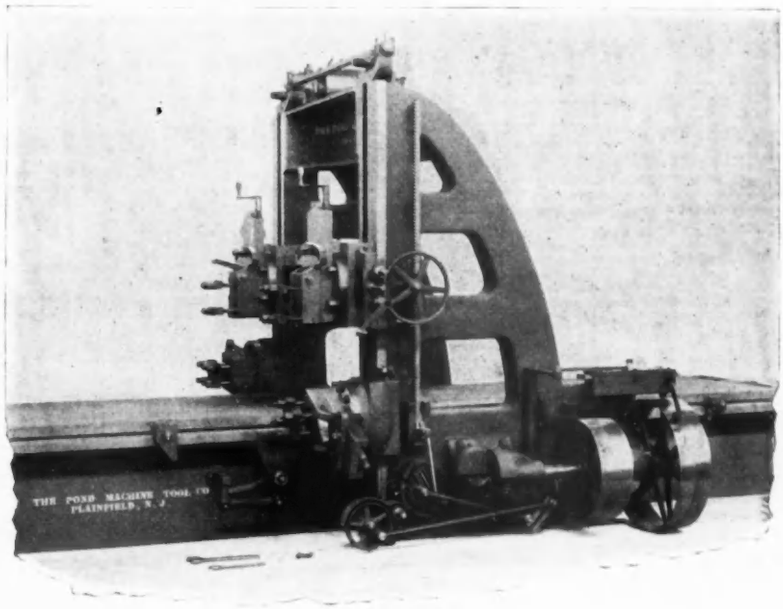
WILLIAMS TYPEWRITER CO.,
253 BROADWAY,
NEW YORK.

The Pond Machine Tool Co. Plainfield, New Jersey, U. S. A.

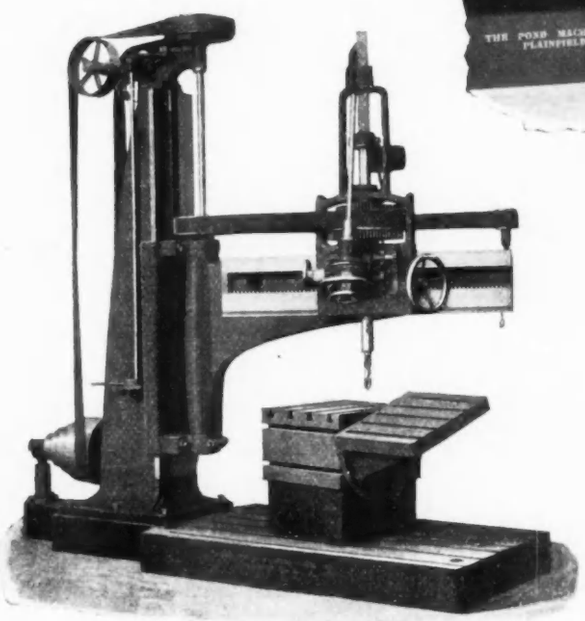
MANUFACTURERS OF

METAL-WORKING MACHINE TOOLS.

AXLE LATHES, DOUBLE AND SINGLE, SPECIAL SHAFT TURNING LATHES, STEEL TIRE CAR WHEEL LATHES, UPRIGHT RADIAL DRILLS.



POND 60" PLANER.



POND RADIAL DRILL.

SCREW-CUTTING ENGINE LATHES THIRTY-INCH SWING AND LARGER,

BORING AND TURNING MILLS,

CAR WHEEL BORERS,

WHEEL PRESSES,

HAND PUNCHING AND SHEARING MACHINES,

RADIAL DRILLS,

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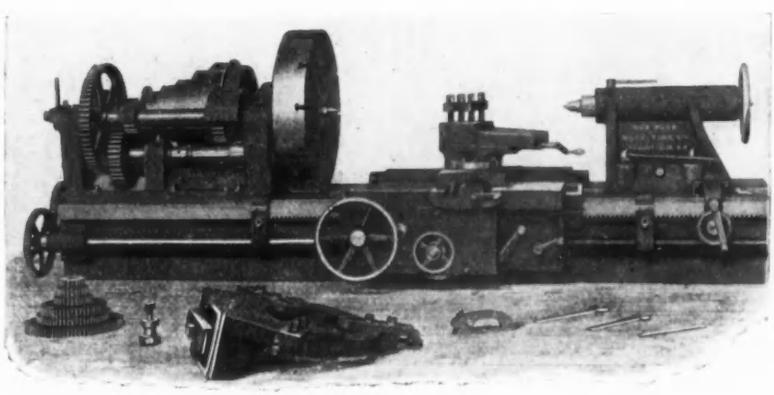
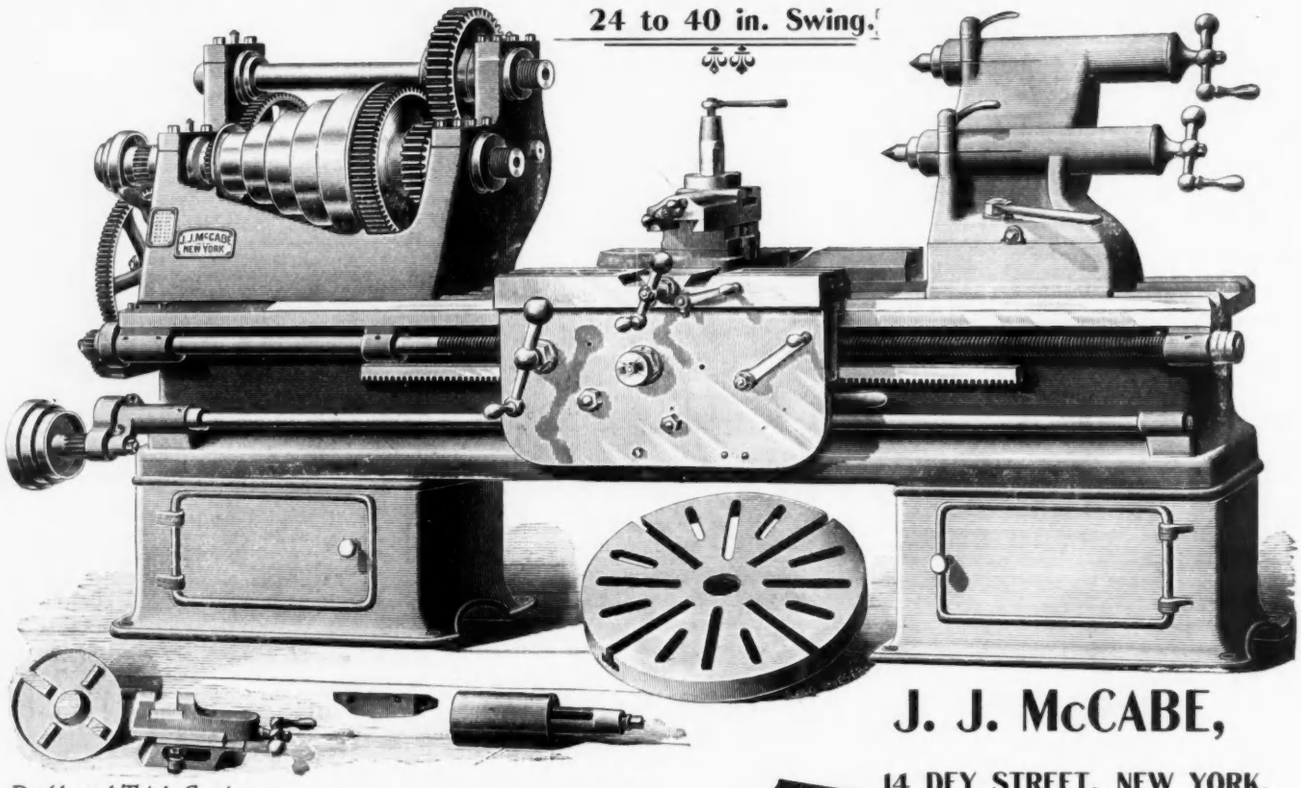


POND 42" LATHE.

"PATENT" DOUBLE SPINDLE LATHE.

24 to 40 in. Swing.



Double and Triple Gearing.
Cone 15 in. Diam., 3½ in. Belt.

Spindles 4 in. Diam., 2 in. Hole.

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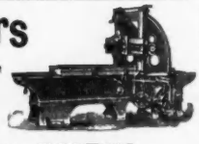

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FLEXIBLE STEEL TUBING.
For Conveying Oil or other Lubricant to and from Cutters, Drills, Etc.
Made of Steel and tinned Norway Iron. By far the best and neatest arrangement for Milling Machines, Bolt Cutters, Gun Boring Machines and other tools. Particulars given on application.
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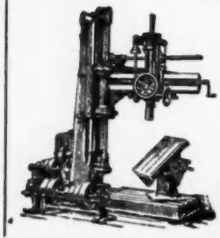
AURORA TOOL WORKS



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WITH PATENT
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From 14 in. to 40 in swing.

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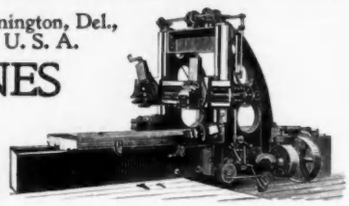
PLANING MACHINES

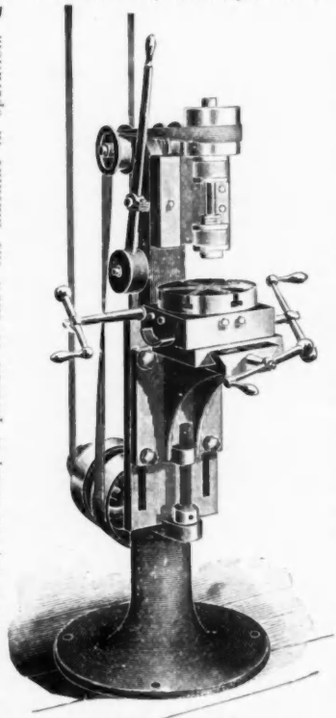
OF MOST MODERN DESIGN AND CONSTRUCTION.

12 Sizes. From 3 ft. sq. to 10 ft. sq.



The Waterbury Farrel Foundry and Machine Co.,

WATERBURY, CONN., U. S. A.



We keep two of these machines always busy in our own shop and find them profitable; we shall be pleased to show the machine in operation.

This machine would be valuable in your Tool Room. For interesting information concerning details, see article in *American Machinist* of April 26, 1894—page 5.

Vertical Milling Machine.
DIE-SINKING MACHINE, PAGE 150 OF OUR CATALOGUE.
Price, with Countershaft, $300 net.
Weight, 650 lbs.